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ABSTRACT

No significant difference of student-concrete physical environment interaction occurred with a change in physical environment. A test was made on five null hypotheses related to the change of physical environment and (1) student-concrete physical environment interaction; (2) environmental preference by students; (3) student attending behavior; (4) student movement within the classroom; and (5) student-concrete physical environment interaction relationship to temperature, humidity, atmospheric pressure, sound level, and illumination level. All data recording and collecting procedures were made through classroom visitations and observations in classes that involved academic subjects. Subjects for the study consisted of 230 elementary and junior high age students located in three separate school facilities in Wisconsin. Forty of these subjects were educable mentally retarded children. All students had been in an "old" structure for at least a month before moving to a "new" structure. Other factors remained constant: classroom unit composition, curricula, teachers, and general time schedule. (Author)/HLF)

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# THE EFFECTS OF PHYSICAL ENVIRONMENT ON CHILDREN'S BEHAVIOR IN THE CLASSROOM

by

William Gingold, Ph.D.

Moorhead State College

1971

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TABLE OF CONTENTS


ACKNOWLEDGEMENTS . . . . . iii

LIST OF TABLES AND FIGURES . . . . . iv

I. INTRODUCTION . . . . . 1

Statement of Problem . . . . . 24

Hypotheses . . . . . 24

Definition of Terms . . . . . 26

II. PROCEDURES . . . . . 29

Population . . . . . 29

Data Collection . . . . . 32

Research Hypothesis One . . . . . 38

Research Hypothesis Two . . . . . 41

Research Hypothesis Three . . . . . 44

Research Hypothesis Four . . . . . 50

Research Hypothesis Five . . . . . 54

The Effect of Change . . . . . 56

Analysis of Data . . . . . 60

III. RESULTS AND DISCUSSION . . . . . 63

Description of Sample . . . . . 63

Test of Research Hypothesis One . . . . . 64

Test of Research Hypothesis Two . . . . . 71

Test of Research Hypothesis Three . . . . . 77

Test of Research Hypothesis Four . . . . . 82

Test of Research Hypothesis Five . . . . . 86
Testing for the Effects of Change . . . . . 89
IV. SUMMARY AND IMPLICATIONS . . . . . 96
The Problem . . . . . 96
Population . . . . . 97
Data Gathering Procedures . . . . . 98
Data Treatment Procedures . . . . . 100
Results . . . . . 102
Implications for Educational Environments . . . . . 104
Implications for Further Research . . . . . 112
Epilogue . . . . . 116
REFERENCES . . . . . 117
Chapter I . . . . . 117
Chapter II . . . . . 125
Chapter III . . . . . 129
Chapter IV . . . . . 131
APPENDICES . . . . . 132

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## LIST OF TABLES AND FIGURES


| TABLE | | PAGE |
|---|---|---|
| 1. | Analysis of Variance for Student-Concrete Physical Environment Interaction . . . . . | 64 |
| 2. | Relationship Between the Difference of Means of Student-Concrete Physical Environment Interaction in "Old" and "New" Environments . . . . | 65 |
| 3. | Student-Concrete Physical Environment Interactions Per Minute in School I by Observation Day, Grade, and "Old" or "New" Environment . . . . . | 67 |
| 4. | Student-Concrete Physical Environment Interactions Per Minute in School II by Observation Day, Grade, and "Old" or "New" Environment . . . . . | 68 |
| 5. | Student-Concrete Physical Environment Interactions Per Minute in School III by Observation Day, Grade, and "Old" or "New" Environment . . . . . | 69 |
| 6. | Total Frequency of Responses to Response to Physical Environment Scale by School and Grade Levels . . . . . | 72 |
| 7. | Change of Environmental Preference . . . . . | 73 |
| 8. | Percentage of Responses Made by Subjects in Three Separate Schools for Each Item on Your Feelings . . . . . | 75 |
| 9. | Total Responses to Your Feelings by Grade and School . . . . . | 76 |
| 10. | Mean, Standard Deviations for Selected Variables . . . . . | 78 |
| 11. | Differences Between Means of Paired Observations on the Draw-a-Classroom . . . . . | 84 |

12. Comparison of Pairs of Mean On-task/ Total Task Time Ratios . . . . . 84

13. Comparison of Pairs of Mean Q to Q Movements Per Minute . . . . . 87

14. Correlations of Attending Behavior with Student Movement Behavior . . . . . 89

15. Comparison of Responses Made by Same Teachers in School I on the IFS in "Old" and "New" Environments . . . . . 90

16. Comparison of Responses Made by Same Teachers in School II on the IFS in "Old" and "New" Environments . . . . . 94

17. Comparison of Responses Made by Same Teachers in School III on the IFS in "Old" and "New" Environments . . . . . 94

FIGURE

1. Flow-Charted Sampling Technique . . . . . 30

2. Example of scaled classroom environment and notations used in the Behavior Quadrant Analysis . . 55

3. Total student-concrete physical environment interactions by grade for Schools I, II and III in "old" and "new" environments . . . . . 66

4. Total mean student-concrete physical environment interaction for School I in "old" and "new" environments . . . . . 91

5. Total mean student-concrete physical environment interaction for School II in "old" and "new" environments . . . . . 92

6. Total mean student-concrete physical environment interaction for School III in "old" and "new" environments . . . . . 93

# Chapter I

## Introduction

Extensive work has been done in the areas of student-teacher interaction and student-student interactions. This work is exemplified in the voluminous works of Amidon, Flanders, Ammons, Bales, and others.[1] Although much research has focused on the teacher and the learner, practically no research has been conducted concerning the physical environment in which the teaching-learning act occurs.

Harmon (1949) indicates that every classroom has two teachers. One teacher is in the form of a person who guides, manages and directs the teaching-learning episodes in the classroom. The other teacher, who is of equal importance, is the physical environment. Numerous studies tell of the importance of the first teacher, but few and only in limited scope, tell of the other.

> Billions of dollars in school construction are being invested by the nation through local boards of education; with practically no research data reflecting the known interface between environmental design and the needs of the learning situation and the learner (Abeson, Appendix #21, 1970, p. 7).

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[1] Anita Simon and E. Gil Boyer, Mirrors for Behavior (Philadelphia: Research for Better Schools, Inc., 1970), Volumes I-IX. This anthology contains seventy-nine systems that are used to observe and study interactive behavior.

This was one of the major concerns that provoked the development of the comprehensive report on Physical Environment and Special Education: An Interdisciplinary Approach to Research by Abeson (1970). Similar sentiments were expressed by Cruickshank and Quay (1970) in a recent position paper which expressed the point that few educational facilities are "conceptualized, designed, and constructed to meet the learning needs of children for whom the structure is intended (p. 261)." On the other hand construction research per se has been quite progressive. Thus it becomes imperative that the physical classroom environment be explored, not just on a molecular (investigation of a single, minute variable) basis but on a molar (investigation of composite of variables) basis.

This position is further emphasized by an earlier observation and statement made by Olgyay (1963) who states that:

> The physical environment consists of many elements in a complex relationship. One can try to describe the environmental constituents as: light, sound, climate, space and animate. They all act directly upon the human body which can either absorb them or try to counteract their effects. Physical and psychological reactions result from this struggle for biological equilibrium. Man strives for the point at which minimum expenditure of energy is needed to adjust himself to his environment. Conditions under which he succeeds in doing so can be defined as the "comfort zone" wherein most of his energy is freed for productivity (pp. 14-15).

Hall (1959) in his classical work indicates "that literally thousands of experiences teach unconsciously that space communicates (p. 190)." If physical space is so important as a stimulus, it must be evaluated in order to determine what critical impact it has on human activity and learning. It may be noted, as Bayes (1967) states that:

> ...experimenters in psychophysics involve the response of isolated sensory perceptions--just vision, just hearing, or just lifting of weights. Since the separation of these senses, however useful it may be for purposes of experimentation, is not expressive of the reality of direct experience. We need additional building blocks like the ones Hall is now developing to represent molar rather than molecular responses (p. 12).

Bijou (1966) indicates that "environment can be evaluated only in terms of the kinds of action it produces and maintains in the child...(p. 21)." This activity if

> ...implicit or overt, educationally purposeful, or extraneous, from the organism's point of view is adaptive or learning activity....The child is set into action not only by the purposeful stimuli of curriculum but also by all the social and physical forces and restraints existing in the classroom (Harmon, 1949, personal lecture notes, n.p.).

Thus, the "child adapts physically in a manner similar to his methods of psychological adjustment. The child grows on a line of stress to reduce stress (Harmon, 1949, personal lecture notes, n.p.)." This position is somewhat contradicted by Roizen (1969). Roizen (1969) feels that "structure and spaces do not exert a direct influence on their occupants

(p. 1)." He further delineates that the space configuration does not cause the behavior. To make this point he gives the example, whereby a bank was simply converted to a bar with a few minor changes. Thus we had the same space, but different functions and therefore different behaviors. In this particular instance a strong case is made for the social implications of the physical environment. "Behavior is affected by the social relationship the building promotes, inhibits, requires or otherwise affects (Roizen, 1969, p. 4)." On the other hand, we must be cognizant, as Bayes (1967) points out, that "...sensory deprivation occurs from prolonged subjection to an unchanging environment (p. 26)" under normal circumstances. Thus Dill, et al (1954) points out that adaptive variations may be genetically determined or they may be environmentally induced.

> The organisms respond to environmental change in different ways according to the time duration which the environmental change persists and according to the magnitude of the stress (C. Ladd Prosser, quote, p. 1).

Studies in the past have focused mainly on one of the following areas of environment: thermal, sonic and luminous. In addition there has been a smattering of research of a global nature involving related environmental components and concepts without specifically focusing on them.

Mintz (1956) in his study found that esthetic surround-

ings have a significant effect on subjects. Two test "examiners" who were unaware that they were subjects for his study, spent prolonged sessions testing subjects in a "beautiful" and in an "ugly" room. Results indicated that "examiners" finished testing much sooner in the "ugly" room. Furthermore the responses by the "examiners" on an esthetic appreciation rating scale were higher in the "beautiful" room than those given in the "ugly" room (Mintz, 1956). Kemp (1955), on the other hand, in an earlier multi-factor inter-correlational study found that the "quality of building (age, interior, state of repair, sanitary facilities) had no relationship with attainment, although it had negative (but barely significant) relationship with interest (in Wiseman's Education and Environment, p. 68)." This same conclusion was reached by Washburton (1968).

Still further thought must be given to this area of study. If we look at the works of Sommers (1967, 1968), we find that seating arrangements, whether in a geriatric hospital or in a university classroom have significant impact on human action and interaction.

Berkson and Mason (1963), in two separate studies which tested the effects of "situational variables on stereotyped behaviors of profoundly retarded adults (p. 412)," showed that subjects increased such behaviors in "novel restricted

environments" and decreased in such behaviors in environments which provided opportunities for alternate activities. The authors used a checklist technique which categorized behavior into four categories: 1) stereotyped behaviors which consisted of body sway, body rock, eye poke, complex hand movements, twirl, hand shake, head nod, head bang, thumb suck, and limb posture, 2) manipulation of environment which consisted of movement of any part of the environment with the hand, mouth, or foot, 3) self-manipulation which consisted of rub, scratch, hit, bite, pick, clasp, masturbation, and mouthing other parts of the body, and 4) locomotion which consisted of body posture (i.e., from sitting to standing, etc.).

Kowatrakul (1959) investigating the relationship between manifested behaviors by fifty-six elementary school children and their classroom activities and subject areas, found that a significant relationship existed in a number of categories.

> [The] particular environment can be described as a stimulus field to which the subjects respond in one way or another. The nature of the response is indicated by the variations in the performance of the activity which may occur with any change in the environment (SER 3, 1965, p. 111).

Implicit in this, is that activity (response to stimuli) can be a direct measure of the impact the physical environment has on the organism. This does not imply that activity is synonomous with learning. "Learning is a process not directly

observable. It is inferred from changes in the performance, which are the behavioral measures taken (Carson, 1965, p. 18)." These measures are observable and can be called activity. Stoke, et al (1960), in a study of student reactions to study facilities, found that the use and approval of study space varies inversely with size. The responses received on an opinionnaire from four hundred under-graduate students by the authors, indicate that 80% declared that small spaces (dormitory rooms, library carrels) were preferable to large spaces (libraries, study halls). Biddle (1967) in An Analysis of Classroom Activities: A Final Report, indicates as an initial comment that "there exists today no general, scientific theory of classroom behavior (p. 2)." Generally he feels that classroom activities have been ignored to date. It is Biddle's contention that "a classroom is a behavior setting (p. 106)." His results indicate that these classrooms are complicated and busy places. This is reflected by the fact that "in the least active classroom, a change of one sort or another occurred on the average of once every eighteen seconds. In the most active classroom, there was a change every five seconds (p. 671)." Furthermore the greatest action occurs in the center band of the classroom and diminishes the farther you go from the front of the room.

Kephart and Floyd (1954), in their analysis of classroom environment, set up two experimental classrooms based on

Harmon's Coordinated Classroom Concept. These two experimental classrooms were matched by two control classrooms which received the same number of physical changes within the classrooms, but not with the Coordinated Classroom Concept in mind. Fourth and fifth grade students were randomly assigned to each of the two classrooms. Results indicated that in achievement the experimental group (fifth graders only) did significantly better. Furthermore the control classrooms were more detrimental to posture and a significant decrease in nervous habits was noted in the experimental classrooms.

> [Thus] man's sense of space is closely related to his sense of self which is an intimate transaction with his environment. Man can be viewed as having visual, kinesthetic, tactile. and thermal aspects to his self which may be either inhibited or encouraged to develop by his environment (Hall, 1969, p. 63).

Peccolo (1962), in a pilot study to determine the effect of thermal environment on learning found, through the use of analysis of variance, that subjects in the experimental environment showed significant gains, particularly in reasoning and some clerical tasks. In this study, he established a standardized set of lessons which was used with two paired fourth grade groups who were equated on a number of variables (i.e., achievement as indicated on the Iowa Test of Basic Skills, mean IQ, age, height, weight, and sex). The

model thermal environment (as he inferred from the literature) consisted of an air temperature of 70°F, relative humidity 40 to 60% and air movement in the range of 20 to 40 cubic feet per minute. No criteria were established to indicate these as optimum for comfort. On the other hand the marginal thermal environment (control classroom) consisted of "regular" classrooms which had temperature ranges of 70°F to 92°F, relative humidity of 33% to 75% and air movement of 5 to 10 feet per minute. The "regular" experimental classroom maintained temperatures of 72°F to 81°F, relative humidity of 35% to 67% and air movement of 10 feet per minute.

Hansen (1966), in a follow up study which used two matched groups of fifth grade students, found that student learning does not seem to be affected by attending school in a controlled thermal environment. Givoni (1962) in his work points out that "man is able to maintain his maximal degree of mental ability even in hot temperatures, provided that he is stimulated enough by incentives...(p. 114)." These results are reflected in the earlier work of Thorndike (1916). Therefore, it seems that the "big problem is to sort out decrements in performance and motivation, since at these levels [comfort levels] of impairment, appropriate motivation appears to be able to override discomfort and these mild environmental stress effects (Goldman, 1968, p. 3)."

Teichner (1958), on the other hand, in eliciting visual-

reaction time responses from 620 soldiers under a variety of ambient temperatures, found that low ambient temperatures (even as low as -35°F) have no effect on reaction time. In a somewhat earlier study Teichner (1955), found that visual-motor performance is markedly and immediately impaired in the cold. Gradual recovery occurred but to a lower limit in the performance attained under optimal temperature conditions. General indications are that manual activities are affected by cold (0°F or below), but this does not seem to be the case for mental activities (McCormack, 1957, Pepler, 1960, Slote, 1963).

Herrington (1952), in his study of human action, found that the accident rate among mine workers was at a minimum at 60°F and increased to a maximum of two to threefold at temperatures approximating 80°F. In his other experiments in code receptions, he found that errors increased from an average of twelve per hour to more than 90 per hour as effective temperature increased from 79° to 97°F. Thus it seems that body heat loss is important to human efficiency. "Between these radical extremes (collapsing-spread eagle or folded with knees up) at which the temperature center orders posture without regard for conscious voluntary desire is the wide area of practical living (Herrington, 1952, p. 371)."

Therefore, from a practical point of view, it's the heat exchange process of the organism that is affected by the

thermal environment (air temperature, humidity of the air, air circulation and temperature of objects such as walls, ceilings, etc.) that exists in the environment (McCormack, 1957).

Brown (1964) concludes that "the relationship between selected climatic variables and classroom behavior is not independent." This conclusion shows a great latitude for interpretation, since it was derived from subjective impressions of 47 teachers who rated their pupils on overall behavior for the day. A similar conclusion was reached some sixty years earlier in a comprehensive ten year study by Dexter (1904). Dexter employed an inductive method whereby comparisons were made "of the average daily occurrence of certain recorded abnormalities of conduct [teacher determined] with their occurrence under definite meteorological conditions (p. 266)." Yet we must be cognizant of the "self-fulfilling prophecy." Recent research data in social psychology tend to give credence to the expectation concept that children will tend to meet reasonable teacher expectations (Rosenthal, 1968, Haskett, 1968, Rosenthal, 1964, Clark, 1965, Rotter, 1954). This is generally achieved through "non-intentional" reinforcement cueing.

Accordingly, it seems that the human organism can efficiently function in a range of thermal environments. This does not imply that this environment is the same for both

young and old alike (Nation's Schools, 1959, Bevans, 1966). Harmon (1951) indicates that

> the incompleteness of growth and development of the school child, and the mass skin ratio of that child as compared to the adult, necessitates a different set of standards for controlling the thermal environment of the school child than those used for controlling the work environment of the adult (p. 2).

Akerman (1965) points out that when the temperature range is from 70°F to 90°F the metabolic rate for otherwise fixed conditions is at a minimum and essentially constant (p. 85)." Consequently in this neutral zone no physiological stress occurs in order to adjust.

Since "growth is only possible when both basal and activity requirements have been fulfilled (Harmon, 1951, p. 2)," and since his "ultimate degree of maturity and performance efficiency are depended upon maintaining his growth rate at an optimum (Harmon, 1951, p. 2)," it becomes necessary to guard against rapid heat loss which causes change in the efficiency of performance. This is reflected in the statistics that school age children's rate of heat production is approximately 47 calories per square meter per hour at age seven, approximately 38.3 calories per square meter per hour at age thirteen, and approximately 20 calories per square meter per hour at adulthood (Harmon, 1951). This is in line with the requirements of approximately eighty

calories per kilogram for school children and forty calories per kilogram for adults (Harmon, 1951).

Consequently the organism will function efficiently when the stress is not so overwhelming that it will cause a change in the internal temperature (Herrington, 1952, Akerman, 1965, Winslow, 1949).

Children learn from experience. What is in that environment provides the experience (Nation's Schools, 1959). Therefore, it is important to examine other environmental factors that contribute to an "Environmental Gestalt."

"Illumination is one of the factors of primary importance to good vision, for even perfect eyes cannot see in the absence of light (Classroom Lighting, p. 3)." Since vision is one of the primary sensory modes for the reception of stimuli, it becomes necessary to consider its effect on human learning and performance. Harmon (1951) in his delineation of the Coordinated Classroom states that

> the human organism strives to grow, develop and function as an integrated whole. In each of its responses to the forces or restraints in its environment which stimulate it, it performs organically by seeking physical balances with forces and constants which meet certain functions of inherently determined system of coordinates (p. 1).

This postulate is exemplified by suppression of vision in one eye if the difference of intensity of illumination amounts to over twelve percent between the two eyes (Harmon, 1951, McVey,

1969, Seagers, 1963). Ott (1968) found in a study of one hundred blind girls that light was correlated with glandular activity. In addition Ott (1968) points out other research which indicated that light influenced the sex ratio in guppies and mice.

Kohn (1967) using a sample of two hundred seventy college students found that different colors and levels of illumination elicited significantly different emotional responses.

Boyd (1965), reporting on Weston's work points out that

> the relationship between performance and illumination depends on the contrast presented by the task. The illumination for maximum performance varies directly with contrast. Thus with equal illumination; however high its value, equal performance of tasks presenting different contrasts cannot be obtained (p. 116).

Thus, "how well the child sees depends primarily on the brightness balance (Handler, 1960, p. 39)."

For subjects to "perceive space in its true three dimensions, the illumination in the space should have a contrast ratio of no more than 1:10 or no less than 1:3 (McVey, 1969, p. 20)." Contrast ratios higher than 1:10 and lower than 1:3 tend to result in distortion and in a loss of three dimensionality.

This light which is a force in the environment "can shape or distort the total child, his eyes, his muscles, his well being, currently or permanently (Harmon, 1946, p. 81)." Implicit in this is that body geometry adjusts to vision.

Consequently,

> visually-induced gradients of activity, when not controlled to meet needs of organisms, can be restraining and handicapping, resulting in limitations of learning, dissipation of energies, or even in warping of growth, development and well-being (Harmon, 1949, Lecture Notes, n.p.).

Support is given to this by the fact that "as the quality of light striking the retina goes down, the readiness of the body to perform decreases (Harmon, 1946, p. 78)." It is further reported that "the eye cannot obtain efficiency and accuracy and speed of seeing with less than ten foot candles of light (Classroom Lighting, p. 6)." Somewhat related but contradictory results were found by Allphin. Allphin (1954), using photographic observation data, demonstrated a lack of substantive correlation between illumination and posture.

Boyd (1965), Harmon (1946), McVey (1969) and Seagers (1963) indicate that in order to obtain maximal visual efficiency, the brightness of the task should be equal to or slightly greater than the visual ground (environment). This, accordingly, would eliminate extraneous distractions. Moreover, if we want to increase the visibility of an object, we merely have to increase the object's illumination.

Spencer (1955) nicely sums up the state of affairs for visual environments in the classrooms for an extended period since World War II:

> Emphasis is placed on the creation of proper environmental characteristics through use of

> proper sources, control surfaces, and materials. It was concluded that none of the day lighting methods satisfy the criterion for an optimum luminous environment for all lines of sight (p. 12).

Barnett (1965), in his discussion of "Sonic Environment and Its Effects on Man," suggests that it's all problematic - no one really knows the relationship. "Sounds too weak to be heard or vibrations too weak to be sensed, do not seem to constitute any physiological problem, but very intense sounds and vibrations do interfere with normal body functions (Barnett, 1965, p. 138)." McCormack (1957), found that there are indications that "while high noise levels or sudden noises do initially affect certain physiological processes, adaptation of these processes is such that they typically settle back to normal, or near normal, levels (p. 199)." Similar results are indicated for noises and their effect on performance (Kryter, 1950). In particular, noises that have high frequencies, high intensities, intermittance and reverberation effects cause the greatest amount of inbalance of human adjustment (McCormack, 1957, Barnett, 1965, and Berrien, 1946).

Broadbent (1953) in his main experiment using eighteen subjects on an unpaced task for a period of one half hour on each of two successive days found that a greater number of errors occurred in the room with the noisy condition than with the same room when a quiet condition existed.

Jerrison (1959) on a follow-up study to check Broadbent's

findings, reported results that performance on a prolonged vigilance task was better in quiet than in noise. Through the use of a clock watching task with nine adults, it was found that decrement in alertness occurred in the noise condition, while none was found in the quiet condition. In addition it was found that the error of time interval estimation was greater in the noise condition than in the quiet condition. Based on his results, Jerrison (1959) concludes that "noise produces readily measurable changes in human performance (p. 96)."

Harmon (1949 Lecture notes) advocates the position that white noise must exist in order for man to adapt. He further points out that by adding thirty decibels (dB) of white noise, optimum body tonus will be produced which is necessary for "alignment of attention to a performance task." The degree of white noise in the environment can present some problems. "With a noise spectrum which is fairly flat the greatest degree of masking will be observed in the frequencies to which the ear is most sensitive (Sanders, 1965, p. 349)." Such a masking situation existing in a classroom would present problems in the intelligibility of speech. On the contrary, masking will have "little effect on the intelligibility of speech, provided the long average intensity of speech is eighteen decibels more intense than the noise throughout the frequency range from 200 to 8,000 cycles

per second (Kryter, 1950, p. 84)."

Woodhead (1966) on the other hand indicates that performance decreases when the decibel level of the noise is well above "comfortable" hearing conditions. Seventy-five decibels is regarded as the comfortable hearing level by the author. This corroborates earlier data by Berrien (1946), that the metabolic rate seems to increase under noise conditions. This is in keeping with a general increase in energy expenditure in the presence of noise. In conjunction with this action, a decrease in saliva and gastric juice flow will tend to exist.

Teichner (1963), in his distraction studies, found that at all sound ratios, performance is better in noise than it is in quiet. Thus a "disoriented condition" arises with the lack of sound (Yerges, 1968).

It must be remembered that sound loudness is subjective and varies with frequency and pressure. Thus in any studies of humans in response conditions, one must consider the subjectivity and bias of the human ear as well as the basic concept that we only measure the properties of things, rather than the things themselves (Stevens, 1951).

McCarthy (n.d.), tried to determine whether there is a linear decrement in performance on easy and difficult cognitive tasks with increases in dB levels. Eighty sixth graders used trigrams which were presented in a paired associate format under different white noise levels (40 dB, 55 dB, 70dB, and 85 dB). This study which was carried on for a period of four days, indicated that performance was curvi-

linear on both easy and difficult learning tasks. Best efficiency of performance occurred at 55 dB.

Park (1963) found no evidence of a decrease in performance due to noise (98-108 dB level), when forty college students were utilized as subjects on division problem tasks. Results did indicate that the variability of "performance was significantly greater with easy problems, under intense noise conditions than under room-noise conditions, although there was no difference with difficult problems (p. 367)." Similar results were found by Berrien (1946). He found that working speed was more affected than accuracy in arithmetic and symbol cancellation by grade school children.

Slater (1968), using 263 seventh graders, found no significance on speed or accuracy of performance on a written task under any of the three experimental noise level conditions (45-55 dB, 55-70 dB, or 75-90 dB). A word of caution may be in order, considering that experimental conditions were of short duration. The results may have been significantly different if they had been over a longer time period.

Hall (1952), using 278 unselected seventh and eighth graders, administered two forms of the Vocabulary and Paragraph sections of the Nelson Silent Reading Test. One form was administered with background music while the other was administered without background music. Results indicate that 58% of the students tested showed improved scores

under the music background. The major accommodation having been made was in terms of increasing accuracy. This was most significant for the below average student. It must be further pointed out that even though the type of background music used was not specified, results do indicate that of the 37% of the group tested who thought that music should be of another type improved only "one fourth as much as those students who liked the selections played (Hall, 1952, p. 456)."

Creswell (1965), using college students, found that students achieved their highest scores on mathematical computation under the quiet conditions and made progressively poorer scores under the higher noise level conditions. Furthermore, students required more time to complete the task under the noisy (75-85 dB) conditions. Similar results occurred in reading, but no difference seemed to occur in performance between the quiet level (20-25 dB) and the normal level (45-55 dB). In addition the authors found that under the higher noise levels, students consumed more oxygen, thus again revealing a higher energy expenditure. Different results possibly could have occurred if the frequencies were not consistent at the different dB levels. Thus the type of noise would have a crucial bearing on the results attained. Furthermore, the results may have been even more spurious without having a frame of reference for the dB readings.

Cook (1970), in his research, indicates that the noise level may possibly be used as an index of classroom control.

He found that "primary EMR classes are noisier (more out of control?) than the intermediate clases (p. 9)." Furthermore he found that "a teacher aide appeared to have a marked effect in reducing noise levels (increasing control?) in a standard size classroom, but not in the class of increased size (p. 9)." In this study class size was determined by the number of students in a given classroom.

Sanders (1965) found that noise levels were generally higher and of greater variability in kindergartens than in other elementary classrooms. This difference may reflect the increased uniformity of the classroom activities with the increased age of the students.

Broadbent (1957) also considered high and low frequencies when studying the effects of noise. He found that high frequency noise produced more errors in performance on a five choice serial reaction task, although the difference was significant only at the highest level of intensity - 100 dB.

> "Thus it appears that sounds more likely to interfere with work also produce a faster reaction when they themselves are acting as signals, confirming a view already advanced about noise effects: that the effect is due to competition between various stimuli to control response (Broadbent, 1957, p. 21)."

Similar results were found much earlier by Morgan (1917).

Hence it is critical that we be cognizant that loudness is not the only component of the acoustical environment. Noise transference, aritculation, and reverberation must also be recognized (Wakefield, 1969, Bloomfield, 1969).

Fitzroy (1963) points out in his survey that:

> 1) Classrooms are less satisfactory where there is a relative high noise reduction coupled with a high articulation index and a reverberent environment. 2) Classrooms are less satisfactory with high reverberation periods or high articulation indices, even with relatively high noise reduction. 3) Generally, where a classroom is alive acoustically, higher noise reductions do not overcome rejections. Conversely, where the classroom is not optimum reverberation environment, lower noise reduction is acceptable. Lower noise reduction also seems acceptable with a low articulation index, bu[illegible] the classroom should not be live acoustically (p. [illegible]

In the final analysis, if the acoustical environment is to have an impact on human behavior it must be continuous (Yerges, 1968). Furthermore, for classroom purposes it may be most important to consider the signal-to-noise ratio. The larger the signal-to-noise ratio, the more satisfactory is the listening (the ability to discriminate between sounds) and therefore, assimilate clear auditory signals (Barnett, 1965).

From the above review of research on the quality of air, the visual environment, and the acoustical environment, we must generally conclude that the results are conflicting. For the most part the experiments that have been done involve responses to isolated environments - thermal, acoustical, visual, etc. The separation of these environments, however useful, is not expressive of reality in the classroom. Thus we need additional "building blocks to represent molar rather than molecular responses (Bayes, 1967, p. 12)."

It is therefore imperative that the interaction between the various factors of environment be considered. The following are examples of the interaction of environmental variables: 1) "Hearing acuity is increased when the level of illumination is increased in the entire room (McVey, 1969, p. 8)." 2) "The sound source (of low energy level) if moved away 27° or more from the center of visual attention, cannot either be heard or discriminated (Harmon, 1969, Lecture)."

The preceding two examples indicate the practical importance of the interaction of environmental variables. Since individuals are not normally exposed to isolated environmental variables, this study will concern itself with the variables as their interaction affects human behavior and activity in established classroom environments.

Statement of Problem

It is imperative that the spending of money for new classroom facilities without a sound basis for effectiveness be recognized and investigated with particular reference to the psychological and physiological impact they have on children's behavior. Therefore, this study will explore the effects of selected physical environment variables on children's behavior in the classroom.

Hypotheses

In order to analyze the problem of The Effects of Physical Environment on Children's Behavior in the Classroom, the following null hypotheses have been presented for testing:

1. No significant difference in the relationship of student-concrete physical environment interaction to the physical environment will occur with a change of physical environment.
2. Environmental preference by students will be non-significantly related to an environmental change.
3. Student-concrete physical environment interaction will show no significant relationship to: temperature, humidity, atmospheric pressure, sound level or illumination level.
4. Student attending behavior will be non-significantly related to the change in physical environment.

5. Student movement behavior within the classroom will be non-significantly related to a change in physical environment.

Definition of Terms:

Activity:

Observable response to environment

Attending Behavior ("on-task"):

This is equal to the total behavior time minus deviant behavior time (See Deviant Behavior).

Behavior:

Activity or change that occurs in relation to the environment.

Behavior Quadrant:

A physical space (approximately one fourth the classroom area) for which overt (observable) behavior will be charted.

Behavior Ratio:

Rate of behavior expressed by the frequency of that behavior divided by the period of time in which behavior occurred.

Concrete-Physical Environment:

Consists of human beings and any man-made physical entities located within a classroom environment (i.e., furniture, equipment, structural objectives and instructional materials).

Deviant Behavior:

Any behavior which is contrary to any rule or instructional objective under which the class or child operates. When there is any doubt about a particular behavior, it is marked non-deviant.

Dross:

The amount of time wasted which could have been utilized for observing and recording student behavior.

Environment:

"The aggregate of all the external conditions and influences affecting the life and development of the organism, human behavior, society, etc... (Webster)."

Facility:

A physical structure used in education to house students for a given purpose.

"New" Environment:

A classroom or building which has been completed within the past year and has never been previously occupied by students.

"Old" Environment:

A classroom or building which is a minimum of five years old based on the initial construction date.

"Open Concept" Classroom:

Classroom facilities that contain minimum vertical obstructions between instructional spaces. In addition, these classroom facilities may be subdivided into smaller units by movable walls or partitions.

Special Education Classrooms:

These are self-contained classrooms for educable mentally retarded students (IQ range of 50-80).

# Chapter II

## Procedures

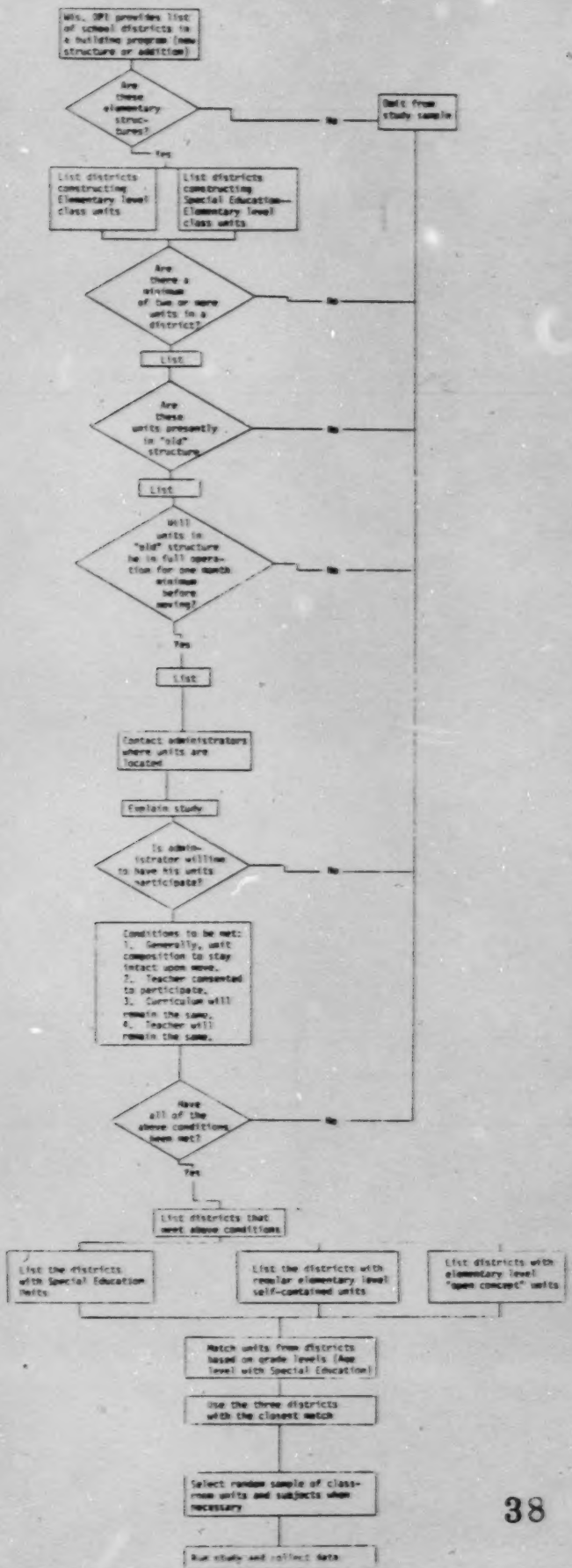
This chapter describes the population, the data gathering procedures, and instrumentation employed to test the research hypotheses presented in Chapter I.

### Population

Subjects for this study consisted of two hundred thirty elementary and junior high age students located in three separate school facilities. Each of the facilities was in a different school district within the State of Wisconsin (Appendix A).

The selection of the districts, schools, and classroom units included for the study was determined by the flow charted sampling technique presented in Figure I. To procure the sample for the study, a list of all elementary school districts in Wisconsin which were in a school building program was acquired from the Wisconsin Department of Public Instruction. Only elementary school districts meeting the criteria of having a minimum of two classroom units for a period of at least one month in an "old" structure before moving to a "new" structure were considered. In addition local school districts had to meet the following conditions: 1) that after the move to the "new" structure, the classroom unit composition would stay intact, 2) that the curricula would remain the same, 3) that

Fig. 1 Flow-Charted Sampling Technique


MDE, OPI provides list of school districts in a building program (new structure or addition)
Are these elementary structures?
No
Data from study sample
Yes
List districts constructing Elementary level class units
List districts constructing Special Education--Elementary level class units
Are there a minimum of two or more units in a district?
No
List
Are these units presently in "old" structure
No
List
Will units in "old" structure be in full operation for one month minimum before moving?
No
Yes
List
Contact administrators where units are located
Explain study
Is administrator willing to have his units participate?
No
Conditions to be met:
1. Generally, unit composition to stay intact upon move.
2. Teacher consented to participate.
3. Curriculum will remain the same.
4. Teacher will remain the same.
Have all of the above conditions been met?
No
Yes
List districts that meet above conditions
List the districts with Special Education Units
List the districts with regular elementary level self-contained units
List districts with elementary level "open concept" units
Match units from districts based on grade levels (Age level with Special Education)
Use the three districts with the closest match
Select random sample of classroom units and subjects when necessary

the teacher for a given classroom unit would remain the same, and 4) that the general time schedule would remain unchanged. Furthermore the school administrators and teachers representing the selected classroom units had to verbalize a willingness to participate in this study.

Based on this selection procedure (Fig. 1), eleven classroom units were identified from three separate school facilities in three separate school districts (Appendix A). No attempt was made to acquire schools which had students representing specific educational and/or socio-economic levels. What resulted was that in School I, subjects represented a middle-class homogeniety, and in School II and School III, a heterogeniety from lower-class to upper-class.

From School I, one-hundred eleven students were included as subjects in the study. These subjects were from grades two, four, five, and six.

School II consisted of seventy-nine students in grades four, five, six, and seven. It may be noted that a grade for grade match was not made between School I and School II. In School I, all of the fourteen elementary classroom units from the "old" facility were transferred to the "new" facility. This was not the case for School II. In School II, only grades four through eight were transferred to the "new" addition attached to the existing structure. Hence, a grade level match existed for grades four, five, and six between School I and School II.

The inclusion of grade two from School I and grade seven from School II was done solely to allow for a possible age-range equivalent match with the educable mentally retarded subjects from the three special education classes from School III. The classification and placement of subjects in School III was based on the Wisconsin Department of Public Instruction's criteria of eligibility for educable mentally retarded children (Wis. Dept. of Public Instruction, 1967, and Heber, 1961).

All forty subjects housed in School III were included in this study. These forty subjects were nearly equally divided in number between primary level, intermediate level, and junior high school level (Appendix A).

## Data Collection

It is significant to note that observational studies involve fewer controls than laboratory experiments.

> The controls that do exist pertain more to the observer and to the means he uses to record data, than to the setting, task, or subject population. Behavior that is the subject of observation tends to be naturally instigated and to have multiple antecedents, whereas fewer antecedents systematically influence experimental outcomes. Behaviors that are recorded in observation tend to be molar, whereas those in experimentation are more molecular (Wieck, 1968, p. 358).

"All scientists agree that measurement of any kind influences what is being measured (Bechtel, 1967, p. 5)." Consequently, intentional or unintentional observer errors must be considered. Haskett (1968) indicates that "observer

errors recorded by researchers were found to favor the direction of their beliefs regarding the data they were collecting (p. 7)." However, these "errors" were "randomly distributed so that statistical analyses were not affected (Haskett, 1968, p. 7)."

In order to minimize observer "errors," highly structured data collecting and recording procedures were utilized in this research. Furthermore, the observer made no attempt to interact with subjects included in the study; therefore, further minimizing the possibility of observer "errors (Rosenthal, 1964, Webb, et al, 1966, and Bechtel, 1967)."

All data recording and collecting procedures utilized in this study were made through in-classroom visitations and observations in the three selected school facilities that met the sampling criteria (Fig. 1). All observations were made in classes that involved academic subjects (i.e., reading, arithmetic, etc.).

For School I, while in the "old" environment, in-classroom visitations and observations were made one day per week on successive weeks. For grades two, five, and six, one in-classroom visitation and observation period was utilized per day. For grade four, two observation periods were utilized. This was the only classroom unit in School I whereby the school schedule provided sufficient flexibility for increasing observation time.

It should be noted that the number of in-classroom visitation and observation sessions varied somewhat between grades in School I. While in the "old" School I environment, the students in grade two were observed for a series of nine consecutive Mondays for a mean observation time of 39.7 minutes. The students in grade four (A.M. session) were observed for eight sessions for a mean observation time of 24.2 minutes. The same students from grade four were also observed for a series of six P.M. sessions for a mean observation time of 25.4 minutes. At the end of the sixth P.M. session, data recording and collection were terminated due to a complete change in subject area and teacher (i.e., reading to physical education). Grades five and six both had nine observation sessions for a mean observation time of 39.1 minutes and 22.2 minutes respectively (Appendix B).

For School II in the "old" environment, students were observed on seven successive Tuesdays, with the exception of grade five (P.M. session). Five observation sessions resulted for this grade level. This was due to specific scheduling difficulties encountered on the first and last weeks. The mean observation time in the "old" environment for grades two, four, five (A.M.), five (P.M.), six (A.M.), six (P.M.), and seven were 17.0, 30.9, 23.1, 17.3, 20.3, and 37.1 respectively. Again it should be noted that two observation periods were devoted to grades five and six

in School II. Again, scheduling within the school precluded an increase in observation time for the other grades.

Similar in-classroom visitations and observations were conducted in School III. Nine successive Thursdays were scheduled for observations for all three classroom units. The actual number of observation sessions accomplished were seven for the primary and junior high school levels and six for the intermediate level. On the second and ninth sessions school was cancelled; one time was due to a field trip and the other time was due to inclement weather. For the intermediate level one other day of observation was omitted. This was due to the absence of the regular teacher in the classroom. The teacher substitute in the intermediate level classroom made a total activity change; therefore, no data were collected for that day.

In terms of mean observation time of students in School III, results were 29.8 minutes for the primary level, 39.6 minutes for the intermediate level, and 42.8 minutes for the junior high school level (Appendix B).

In all of the three schools the dross rate was quite extensive. Of a possible 1,680 minutes of observation time in School III, only 744 minutes or 44.3% of the time was solely used to observe behavior by students. The rest of the time was utilized setting up, using, and dismantling other instruments not requiring observation of student

behavior. In addition "waiting time gaps" existed due to the unique scheduling within each individual school.

For School I a similar dross problem existed. Of a possible 3,019 minutes available for student observation, only 1,255 minutes or 41.6% were actually utilized. The same condition existed for School II, whereby of a possible 2,348.5 minutes of student observation time, only 974 minutes or 41.5 % were actually utilized for student behavior observations with the remainder being dross.

The dross rate did not change significantly when classroom units were located in the "new" environment. School I showed an increase in dross rate from 48.4% to 52.5%. Schools II and III showed a decrease in dross rate from 45.7% to 43.0% and from 45.7% to 44.9% respectively.

The data collection procedures in the "new" environment were identical to the procedures employed for the classroom units in the "old" environment. The changes that were required in the "new" environment related basically to the dates of commencement for in-classroom visitations and observations.

Due to various unforseen construction difficulties encountered by all three schools, the completion dates for the facilities were somewhat delayed. The delays for moving the classroom units to the "new" environments were approxi-

mately five weeks in School I, nine weeks in School II, and four weeks in School III. In order to adjust to these new time limitations, in-classroom observations commenced on the first day of school in the "new" environments for Schools I and III. For School II in-classroom observations commenced on the third day in the "new" environment. Because of the extensive delay for School II, it became necessary to have in-classroom observations twice a week (Wednesday and Thursday). The time periods and classes for the additional day per week of observation in School II were identical to the regular observation day (Thursday).

For the classroom units in School I in the "new" environment, seven successive Mondays were utilized for observation. Grade four (P.M.) from School I was deleted from observation. This was a result of a change in teacher and program. (Appendix B).

In School II, the classroom units were observed for seven successive Thursdays. Grade five (AM) from School II was dropped from observation in the "new" environment due to a change in schedule within the school.

Eight observation sessions were possible of the projected nine for the intermediate and junior high school special education classes in School III. For the primary level unit, six observations were made out of the projected nine.

The section that follows will delineate the instrumenta-

tion and specific data collection procedures that were utilized for the research hypotheses in this study. They will be dealt with in sequence as previously presented.

Research Hypothesis One

No significant difference of student-concrete physical environment interaction will occur with a change of physical environment.

To test this hypothesis, the following five categories were established which were used to express various aspects of concrete physical environment within the classroom: 1) Human contact, 2) Immovable structures, 3) Movable furniture, 4) Equipment, and 5) Instructional materials (Appendix C).

These categories outlined the dimensions for physical contact within a classroom. In addition it provided the situational foundation for observed interaction with concrete physical environment by students in a classroom (Gellert, 1955, Cattell, 1963, and Thomas, 1921).

To determine the rate of student-concrete physical environment interaction, an objective observational technique was used. This required that a subject be systematically observed on the pre-determined categories for a specified time sample. Loomis (1929), observed the actual physical contacts that nursery school children made with each other for four one-half hour periods. Even though the treatment

of her data was with a statistical mode, she felt that it would be difficult to completely eliminate subjective interpretation from observing physical contacts.

To minimize this subjectivity, Madsen, et al (1950), employed a highly structured systematic direct observation technique of student behavior. This was later modified by Werry (1960), and used in the analysis of "on-task" behavior of elementary school children. The most recent use of this direct observation record has been by Nelson (1971), in utilizing it to record overt behavior. Nelson (1971), observed each child for "two 20 second periods out of each minute, during which time overt behavior was classified and recorded, using symbols developed by Werry and Quay (p. 503)."

A number of other researchers have utilized different forms of a structured systematic direct observation technique in recording behavior of individuals (Kowatrakul, 1959, Katz, 1968, and Biddle, 1967).

For the purpose of this study each student in each classroom unit included in the study was observed in sequence. Observing began with the first row from the left when the observer was facing the class. A student was rated each successive thirty seconds, proceeding down the first row, then starting with the front student in the second row, then continuing in this manner throughout the room. In the event a subject was not in his seat when his time came to

be observed, he was located, only when in the classroom, and then observed. The same procedure was followed for any student who was temporarily out of the room.

In situations where the seating patterns were not in definitive rows, the observer started observing subjects closest to him in the behavior quadrant in which he was sitting. From the closest subject, observation progressed to the next closest and so on within the quadrant. When all subjects were observed in a given quadrant, the observer then went into the next quadrant, in a clockwise direction, until observation returned to the point of origin. This was repeated as many times as the observation time periods would allow.

When observing each subject for a thirty second interval (stopwatch timing), the observer recorded the physical contacts that were made on the five categories utilizing a manually operated, multi-unit digital counter. Only interactions that met the criteria of having a minimum two-second time duration, a definable beginning and end, and were able to pass the dead man's test (if a dead man can do it, don't count it) were recorded.

An attempt was made to maintain similar time blocks in both "old" and "new" environments. When it became necessary to deviate from this observational schedule, steps would have been taken to have observational periods for identical

activities (i.e., reading, arithmetic, etc.) This would have been done in order to eliminate the introduction of another variable which is the subject area. It was felt that a change in the time of day for the same subject would have a smaller activity variance than a change in the subject area. As the study progressed, this unwanted situation did not materialize.

Based on this procedure, the frequency data resulting from the student-concrete physical environment interaction was charted on six-cycle logarithmic graph paper developed by Ogden Lindsley (n.d.). The use of this type of "logarithmic chart system allows a proportional representation of data, and eliminates the distortion normally obtained from "ruler" type charts (Bradfield, 1970, p. 23)."

Research Hypothesis Two

Environmental preference by students will be non-significant with an environmental change.

To test this hypothesis, the Response to Physical Environment Scale was developed and utilized. The instrument consists of twenty-three pages, with a triad of black and white classroom photographs on each page (Appendix D). Each photograph from the triad represents one of three types of classroom environments; a well maintained "old" self-contained, rectangular cell shaped classroom, a "new" self-contained, rectangular cell-shaped classroom, and a

"new" open-concept, "pie-shaped" classroom area separated from adjacent spaces by a sliding partition.

A special 35 mm Panoramic camera with a 135° yisual field swivel lens, which provided minimal distortion, was utilized to make the photographs for this instrument.

When constructing the instrument, photographs were taken of the three different classrooms containing similar physical entities in approximately the same physical position in relation to the front of the classroom environment as denoted by teachers occupying respective classrooms. In the self-contained classrooms, the window drapes were drawn closed. This was done in order to eliminate the attention-getting component of looking beyond the defined space of the classroom environment. In the open-concept environment this was not necessary due to the complete lack of windows. In this particular environment a door leading directly to the out-of-doors provided some natural light to the defined area. This door was not covered when the photographs were taken.

All photographs were taken under conditions of having the lights turned on, utilizing an F stop of 2.8 at a speed of one-thirtieth of a second with Kodak ASA 400 black and white film. Foot candle readings were taken at the time the photographs were taken. These readings were not utilized in any form in the scale or in the research since the printing process negated the significance.

Black and white photographs were selected over color in order to minimize the possible bias that exists for color preference (Srivastava, 1968). It is without doubt that color photographs would have provided the subjects with an easier means through which to identify materials and objects within the environment, thus possibly resulting in target focusing (Handler, 1960).

It may be noted in the instrument on the first nine triads that a near-parallel exists in relation to the inclusion and location of physical entities within the classroom environments. The other triads on the succeeding pages of the instrument consisted of the same photographs as found on the first nine pages, but mix-matched with each other based on the sequence presented in Appendix E. This mix-match was introduced in the instrument in order to determine whether the inclusion of the number of physical entities as well as the "orderliness" of the classrooms were other variables which could be considered for study at a future time.

Based on the delineated procedures, the result was the Response to Physical Environment Scale. In order to determine the instrument's reliability, it was administered to a total of sixty-six subjects from grades three, four, and eight (Appendix F). Based on a modified Sign-Test for Matched Pairs (Hays, 1963), a z value of 2.36 resulted on a test-retest basis after a one week interval. Transforming z to r it was

found that the reliability coefficient was 0.9823 significant at the .02 level using a two tailed test.

Having determined the reliability of the instrument and having found it to be at an acceptable level, it was administered by the classroom teachers to their respective students according to the directions found in Appendix D.

The pre-testing of the subjects included in this study was accomplished in the "old environment" on the last observation week. This was done on a day other than the day the actual in-classroom observation was occurring.

The same instrument was re-administered according to the same directions (Appendix D) to the same subjects, again on the last observation week in the "new" environment. The time lapse between administering the pre-test and post-test was approximately four and one-half months. This time period was of sufficient duration to make memory recall on marking the same triads insignificant.

Research Hypothesis Three

Student-concrete physical environment interaction will show no significant relationship to: temperature, humidity, atmospheric pressure, sound level, or illumination level.

To test this hypothesis, the interaction data on a fixed time sample per subject acquired using the Student-Concrete Physical Environment Interaction (Appendix C) instrument from hypothesis one was utilized in conjunction with the measures of

temperature, humidity, atmospheric pressure, sound level, and illumination level.

The following outlines the instruments and procedures that were used to acquire the necessary data to test this hypothesis and its components:

1. Temperature--

   A Taylor Maximum-Minimum thermometer was used to determine the highest and lowest temperatures reached during each observational time block. From these two readings the amount of temperature change was determined for each observation period. In addition a temperature reading was taken for the beginning and end of each observational time block. Based on the four readings, a mean temperature was determined for each observational time block.

2. Humidity--

   A Taylor Wet and Dry Bulb Sling Psychrometer was used to measure the relative humidity of the classroom environment. Readings were recorded for the beginning and end of each observational time block. The combination of these two readings was used to determine the mean percentage of relative humidity in each classroom environment for each observational time period. In addition a change in the relative humidity and its direction were

noted for each observational time period. Both the mean relative humidity and the relative amount of change for an observational period constituted the data which was to be statistically treated.

3. Atmospheric Pressure--

A Selsi Aneroid Barometer was used to measure the atmospheric pressure in each classroom for each time period. Two readings were taken. One reading at the beginning of the observational period and one at the end. It was the difference between these two readings which was indicative of rising or falling pressure. The means between these two readings were utilized in the statistical procedures which are discussed in the next chapter.

4. Sound Level--

A Scott Sound Level Meter, type 450-B with an omnidirectional Rochelle-Salt crystal microphone was used to determine the sound level for each classroom environment. This sound level meter which had a sound level range of 26-141 dB and a frequency range of 25-8000 Hz was used each successive five minute interval on the standard A, B and C weightings. The spread of

the figures for the three scales can be a "direct indication of the relative amount of low-frequency strength in the overall signal...(Scott, n.d., p. 4)." The C scale was utilized to give a measurement of the actual Sound Level Pressure while the A scale was used as a single-number evaluation of "noisiness" or annoyance factor.

Sound level readings were taken after each five minute observation of student behavior. These readings were frequently taken because they were subject to change quite readily with a change in the instructional program. Based on the total number of sound level readings for each observational period, a mean was computed for each scale. The means for each scale as well as the difference between the means and the ambient sound level for all classroom environment were determined and utilized in the treatment of data. In all cases, the ambient sound level reading of each classroom environment was recorded in late afternoon when all students and staff had departed from the school's premises. One ambient sound level reading was taken for each classroom environment at the beginning of the observation sessions and one at the terminal session. Based on these two

ambient readings on each of the three scales a mean was derived for each classroom environment in both the "old" and the "new" environments. All ambient sound level readings were taken with the heating-systems on.

Strict attention was given to the acquisition of this sound level data. In the environment, a sudden sound can preempt attention (Mathews, 1966). This can consequently imply an immediate change in behavior.

5. Illumination Level--

A Gossen Foot Candle Meter #526 with a three-scale, 0-600 f.c., range was used to acquire the illumination and reflectance light level readings for each classroom environment during each observation period.

Four illumination and reflectance readings were taken at the beginning of each observational period in each classroom environment. These readings consisted of one illumination and one reflectance reading from the center of each of the classroom behavior quadrants. Illumination readings were taken when the meter was held at the desk top, while reflectance readings were taken at a distance of fourteen inches from the

desk tops. Based on these readings for each classroom environment, a mean illumination and reflectance ratio was computed.

Handler (1960) indicates that "visual conditions of a schoolroom cannot simply be gauged by the amount of candles each child has. How well the child sees depends primarily on the brightness balance (p. 39)." Considering this crucial aspect of illumination, a brightness ratio between levels of illumination and levels of reflectance was utilized in the statistical treatment of this hypothesis.

All commercial instruments employed to test existing hypotheses were calibrated by the Department of Meteorology and the Instrumentation Systems Laboratory of the University of Wisconsin prior to the in-classroom observations in the "old" and "new" environments.

Due to the time, equipment and scheduling limitations imposed on this study, data on the mentioned variables was collected as frequently as possible without upsetting the existing school program and individual teaching situations. This was done in consideration for "both moment-to-moment and continuing physical adjustments [that] are made to the shifting gradients of physical forces represented by the distribution of light, sound, temperature,...existing in the surround (Harmon,

1950, p. 49-50)."

Research Hypothesis Four

Student attending behavior will be non-significant with a change in physical environment.

To test this hypothesis, two instruments were used. One instrument was used to determine the frequency of attending behavior to physical entities within the classroom defined environment. The other instrument or technique was utilized to determine the duration of attending ("on-task") behavior.

The Draw-a-Classroom was utilized to measure the frequency of attending behavior to physical entities in the classroom environment (Appendix G).

Even though drawings have been extensively used as projective techniques in clinical psychology, the Draw-a-Classroom did not have such an intent. But the instrument that was developed and utilized was based on some of the following psychological assumptions:

1. "The child draws as he knows, not [necessarily] as he sees (Harris, 1963, p. 207)." This may be the reason why errors often exist in children's drawings when compared to the original environment.
2. "Drawings document the progressive maturation of intellect, his view of the world about him, and his feelings toward that world of persons and things (DiLeo, 1970, p. 26)."

3. Children tend to draw what impresses them. (Dileo, 1970).

4. "The art of children discloses their characteristic modes of understanding--their visual realizations in imagery--at different stages of development (Lindstrom, 1964, p. 1)."

Prior to the use of the Draw-a-Classroom to test this hypothesis, it was piloted with a group of twenty third grade students to determine its test-retest reliability. Test-retest reliability resulted in a coefficient of 0.4895 significant at the .01 level for a two-tailed test. This level of reliability is acceptable when the test-retest conditions are considered. Based on the previously stated psychological assumptions, a seven-day interval between test-retest as employed with the pilot, may have been much too long. This is coupled with the fact that during that one-week interval a number of physical changes occurred within that classroom which were directly attributable to the regular instructional program and which were uncontrollable in nature in terms of the test-retest.

In addition to determining the reliability of test-retest for the Draw-a-Classroom, a score-rescore reliability was made of two independent samples not included as experimental subjects for this research. One group consisted of twenty-one sixth grade students. The reliability for the score-rescore for this group was 0.8276 which has a t value of 6.9746 which is at the

.001 level of significance on a two-tailed test. The other group consisted of ten subjects in a primary special education class. The score-rescore reliability for this group was 0.794 which was found to be significant at .001 level for a two-tailed test. Consequently the scorer was able to maintain a high scoring stability for two independent samples, which had subjects who responded with a large quality variance in their representational drawings.

This instrument (Appendix G) was administered to the subjects in this study on the last week of observation while in the "old" environment and then again when in the "new" environment. All subjects were requested to draw a picture of their classroom on an 8 1/2" X 11" blank white sheet of paper. Subjects drew pictures of their respective "home" classrooms while in another room. No time limit was set in the administration of the instrument. Scoring of the instrument entailed a simple frequency count of all the physical entities included in the drawings. This frequency count was utilized in the analysis of attending behavior to physical environment.

To limit the frequency variance that possibly could have occurred through student confabulation, photographs were taken of the classrooms during the same week that the subjects responded to the Draw-a-Classroom instrument. This allowed the examiner an opportunity to compare the subjects' drawn responses with photographs representing the actual classroom.

No consideration was given to esthetic quality of the drawings or other related factors in this study.

The other instrument used to determine attending behavior was the actual observation of subjects' "on-task" (attending) behavior (Patterson, 1969, Nelson, 1971, and Werry, 1960). For each observational time block, "on-task" behavior was recorded for each subject within the classroom environment. "On-task" behavior time was considered in light of the instructional objectives that each teacher verbalized or put in writing in order to provide the necessary directions to the students.

The sequence for observing each subject was identical to the procedure utilized in observing and recording student-concrete physical environment interaction. Instead of recording the frequency of behavior, the time duration of "on-task" behavior was observed and recorded using a stopwatch. This was done for each subject within the classroom environment on successive thirty-second time samples. Consequently a cumulative "on-task" behavior time was derived for all subjects within each classroom environment for any given observational period. This cumulative "on-task" behavior was then converted to the amount of "on-task" behavior time per subject per total time of observation. This procedure of observing and recording "on-task" behavior was accomplished for sample subjects while in both the "old" and the "new" environments.

No reliability testing was done to determine the consistency for the "on-task" observation and recording technique. Previous work in utilizing this technique reports high reliability and validity (Barker, 1929, Werry, 1960, Patterson, 1969, and Nelson, 1971).

Research Hypothesis Five

Student movement behavior within the classroom will be non-significant with a change in physical environment.

To test this hypothesis the Behavior Quadrant Analysis was utilized (Appendix H). This instrument consisted of separate scaled diagrams for each of the classroom environments included in the study. The use of scaled floor plans to record subject movements or location of physical entities in the environment is not unique.

Barker (1929), used scaled floor plans on which to chart nursery school childrens' movements at specific time intervals. In this research the observers used colored pencils as a code to denote movement from one thing to another and from one person to another. Results from her study, using a twenty-minute record on each of sixteen nursery children ages two to three, showed that of the 1,168 activities recorded, 61.89% were spent on material objects and 19.90% were spent on material and social objects.

In a later study the scaled classroom floor plan was utilized by Sanders (1958) in an attempt to determine the

relationship of classroom furniture and the instructional program. A most recent utilization of this approach has been made by interior designers (Cain, 1971).

Accordingly, a scaled drawing for each classroom environment was duplicated nine times on an 8 1/2" x 11" sheet of paper (Appendix I). The actual space of the scaled classroom environments was divided into four, approximately equal sections or behavior quadrants (Fig. 2).

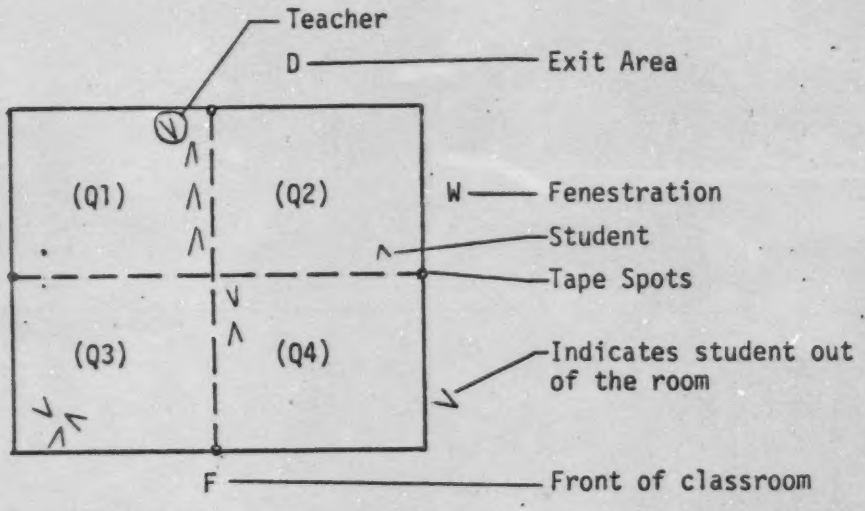



Fig. 2 Example of scaled classroom environment and notations used in the Behavior Quadrant Analysis.

These quadrants were discretely marked by "tape spots" in the actual classroom environments. Furthermore, directional reference was given to the front (F) of the classroom and to the location of the fenestration (if any) and the exit area

by marking the W and D respectively.

In classroom environments that lacked clearly defined area limits, random selection of subjects (N=6) from each classroom environment were asked to physically define the area that belonged to their classroom unit. In all cases, the subjects clearly defined the area that belonged to them. Based on this information, the necessary scaled drawings were made.

Using the Behavior Quadrant Analysis, locational and directional notations were made of all the subjects within the defined classroom environment at each five-minute interval for all the observation periods. Thus each scaled classroom environment denoted the location and position of all subjects within that environment at a point in time after each five-minute interval.

The same procedure was used to indicate the location and position of the teacher.

Based on the recorded notations for student location within each quadrant, a total frequency count was made for the quadrant to quadrant movement for each observation period. As a result, the rate of quadrant to quadrant movement was derived for each of the classroom units for both the "old" and the"new" environments.

The Effect of Change

Due to the possibility that the Hawthorne effect may exist in relation to the acutal change from the "old" to

the "new" environment, procedural steps were taken to determine if this was the case.

One approach to determine if changes occurred in student behavior due to the change only was to have the students observed in their "new" environment on the very first day. This "first day" data were compared in relation to the rest of the data for the "new" environment. "First day observation data were possible for Schools I and III. For School II, first week observation data were recorded. This was necessitated by the scheduling difficulties that were impossible to circumvent.

Another approach was utilized which attempted to determine whether the changes in student behavior were mainly due to attitude changes that occurred in the subjects' teachers. It has been known for some time that the "self-fulfilling prophecy" exists to various degree. Clark (1965), in his study found that:

> the evidence of the pilot projects in "deprived" schools - odd though it may appear to many - seems to indicate that a child who is expected by the school to learn does so; the child of whom little is expected produces little. Stimulation and teaching based on positive expectation seem to play an even more important role in a child's performance in school than does the community environment from which he comes (p. 132).

Thus a modelling affect exists, whereby subjects follow response patterns similar to the model (Rosenthal, 1964, Haskett, 1968, and Rotter, 1954). Therefore, if teachers

viewed the change of environment as positive, these attitudes, however unintentional, would be conveyed to the subjects. After which, subjects would show similar response patterns.

To consider this crucial aspect of this interaction, the Impact of Facilities Scale (IFS) was utilized (Appendix J). This instrument is based on the general format quite often associated with the Semantic Differential (Osgood, et al, 1967).

Based on a very small sample of teachers (N=4) in a "new" facility, Form A-2 of the Impact of Facilities Scale was used to determine the test-retest reliability of the instrument. By utilizing the Pearson Product-Moment Correlation for the means of the fifty-two items after a test-retest interval of one week, it resulted in an r equal to 0.694, significant at the .001 level.

The instrument is made in two forms. Form A-1 was administered to all staff while in the "old" environment. It elicited their reactions as to how the "new" school facility would affect their students and possibly their own feelings. Their responses were noted on an unmarked line between two dichotomous words which were used to complete sentences presenting possible behaviors that could occur.

As a post-test measure for the "new" environment, the staff responded to IFS - Form A-2. This form elicited their reactions as to how they felt the "new" environment

did affect their students and possibly their own feelings.

Both forms of this instrument were administered to teachers during the last week of observation in both the "old" and "new" environments. Identifying one's name with their respective completed instruments was made optional. It was felt that by listing their identification, responses would become somewhat skewed.

The scoring of the instrument was based on a fifty centimeter Likert-like scale. Thus each line between the two dichotomous words was 50 cm. in length. The measurement of these lines was not made known to the respondents. Each marked line was measured using an overlay (Appendix J). Thus for each item that the respondents marked, a value was given based on the overlay's indication. Consequently, the mean score for each item on Form A-1 was statistically treated with the score on Form A-2 for each school in order to determine expectation achievement levels.

Another instrument, Your Feelings, was used with student subjects as a validation index for response trends made to other instruments. This instrument consisted of ten statements pertaining to each student's own personal feelings in relation to the physical environment (Appendix K). It was through this instrument, that each subject could compare the "old" environment to the "new" environment based on ten generalized behavioral variables.

## Analysis of Data

Analysis of the composite data regarding the Research Hypothesis One, the effects of "new" physical environments on student-concrete physical environment interaction, was completed by means of analysis of variance utilizing the NWAY 1 STATJOB on the Univac 1108 computer at the University of Wisconsin Computer Center. This program, which allows for an unbalanced design with approximate replicates, performs an unequal cell analysis. This was supplemented with the t-Test between differences of means with unequal N for each school independently. Thus in effect, the analyses provided an indication and evaluation of the stability of measures over a prolonged period of time.

By utilizing the mean frequencies of student-concrete physical environments for each observation period in each classroom, the analysis was made possible of the identical variable in two independent environments ("old" and "new"). Consequently this type of analyses provided a control on differences between subjects. Therefore each group of subjects within each classroom environment served as their own control (Winer, 1962).

Data relating to Research Hypothesis Two were analyzed for the effect of the treatment ("new" environment) on the subjects' environmental preferences as indicated by the Response to Physical Environment Scale.

The Complex Chi-Square and contingency coefficient (Bruning, 1968), were utilized on the data acquired from the Response to Physical Environment Scale to determine significant differences of responses made by subjects within each school district while in the "old" environment and when in the "new" environment.

To test Research Hypothesis Three, the relationship between student-concrete physical environment interaction and temperature, humidity, atmospheric pressure, sound level, and illumination level, a product-moment correlation was carried out on the DISTX computer program prepared by Spuck (1971), which utilized a modification and merger of the descriptive statistics program (DISTAT - University of Wisconsin) and the intercorrelation program (MDRS - Veldman, 1967). Data used for the correlation consisted of one hundred eighty-six observations both in "old" and "new" environments.

In the analysis of the data pertinent to Research Hypothesis Four, the significant difference in attending behavior with a change in physical environment, was done independently for each of the instruments utilized to measure this variable. The t-Test for the difference of two sample means was used on the data derived from the "on-task" observational behavior technique based on 186 observations of twelve separate classroom units in "new"

and "old" environments.

The data derived from the Draw-A-Classroom were analyzed using the t-Test for the difference between paired observations. This analysis was done individually for all classroom units (N=11).

In exploring Research Hypothesis Five, the rate of student movement behavior and its significance to the change in physical environment, statistical treatment was provided through the use of the t-Test for the difference between the two sample means which have an uneven N.

To possibly answer the rhetorical question concerning the Hawthorne effect, a repeated measures design was used to treat the responses derived from the Impact of Facilities Scale. Percentage comparisons were used on the Your Feelings instrument to which the sample subjects responded.

# Chapter III

## Results and Discussion

This chapter presents a description of the sample, the statistical methods used, and the results and discussion of the present investigation relative to the research hypotheses.

### Description of Sample

The experimental participants consisted of two hundred, thirty elementary and junior high school age subjects from eleven different classrooms in three separate school districts in Wisconsin.

Each of the three school districts met the criteria of having a number of classrooms (minimum of two) in an "old" school facility which moved into "new" facilities at the beginning of the second half of the school year. In addition these classroom units continued their basic curricula, scheduling, groupings, and instructional approaches when in the "new" facility.

Consequently this provided the study with experimental subjects from the eleven different classrooms who acted as their own control group. Thus any changes indicated by the subjects' behavior could then be inferred to be the result of the change in physical environment as

represented by the "new" facilities.

Test of Research Hypothesis One

The null hypothesis stated that no significant difference of student-concrete physical environment interaction would occur with a change of physical environment. To treat the data of one hundred, seventy-three observations, the NWAY 1 STATJOB on the analysis of variance with repeated measures and Scheffe's approximations for an unbalanced design were utilized from the University of Wisconsin Computer Center.

Based on the unequal cell analysis of the student-concrete physical environment interaction of subjects in the "old" and "new" environments, results support the acceptance of the null hypothesis (Table 1).

TABLE 1

Analysis of Variance for Student-Concrete Physical Environment Interaction

| Source | SS | df | MS | F | p |
|---|---|---|---|---|---|
| Total | 0.6539 | 172 | -- | -- | -- |
| Old | 0.2198 | 11 | 0.2198 | -- | -- |
| New | 0.0298 | 1 | 0.0298 | -- | -- |
| Between | 0.0407 | 11 | 0.0037 | 1.5417 | N.S. |
| Within | 0.3611 | 149 | 0.0024 | -- | -- |

A closer look by individual schools indicates that a change in environment did not affect the total student-concrete physical environment interactions in Schools I and III (Table 2). The change of environment for School II shows that student-concrete physical environment interaction was significantly ($p < .01$) affected.

TABLE 2

Relationship Between the Difference of Means of Student-Concrete Physical Environment Interaction in "Old" and "New" Environments

| Source | $\bar{X} - \bar{Y}$ | df | t | p |
|---|---|---|---|---|
| School I | .113358 | 61 | 0.7438 | .20 |
| School II | .500996 | 66 | 3.2582 | .01 |
| School III | .102143 | 39 | 0.8990 | .20 |

This is further represented in Figure 3 on a logarithmic graph which provides a ratio scale making it possible to compare frequencies of behavior for unequal observation time intervals.

Scrutinizing the data, it is noted that the mean student-concrete physical environment interactions decreased for Schools I and III but not at a significant level (Tables 3 and 4).

Fig. 3. - Total student-concrete physical environment interactions by grade for Schools I, II and III in "old" and "new" environments (——— "Old," - - - "New")

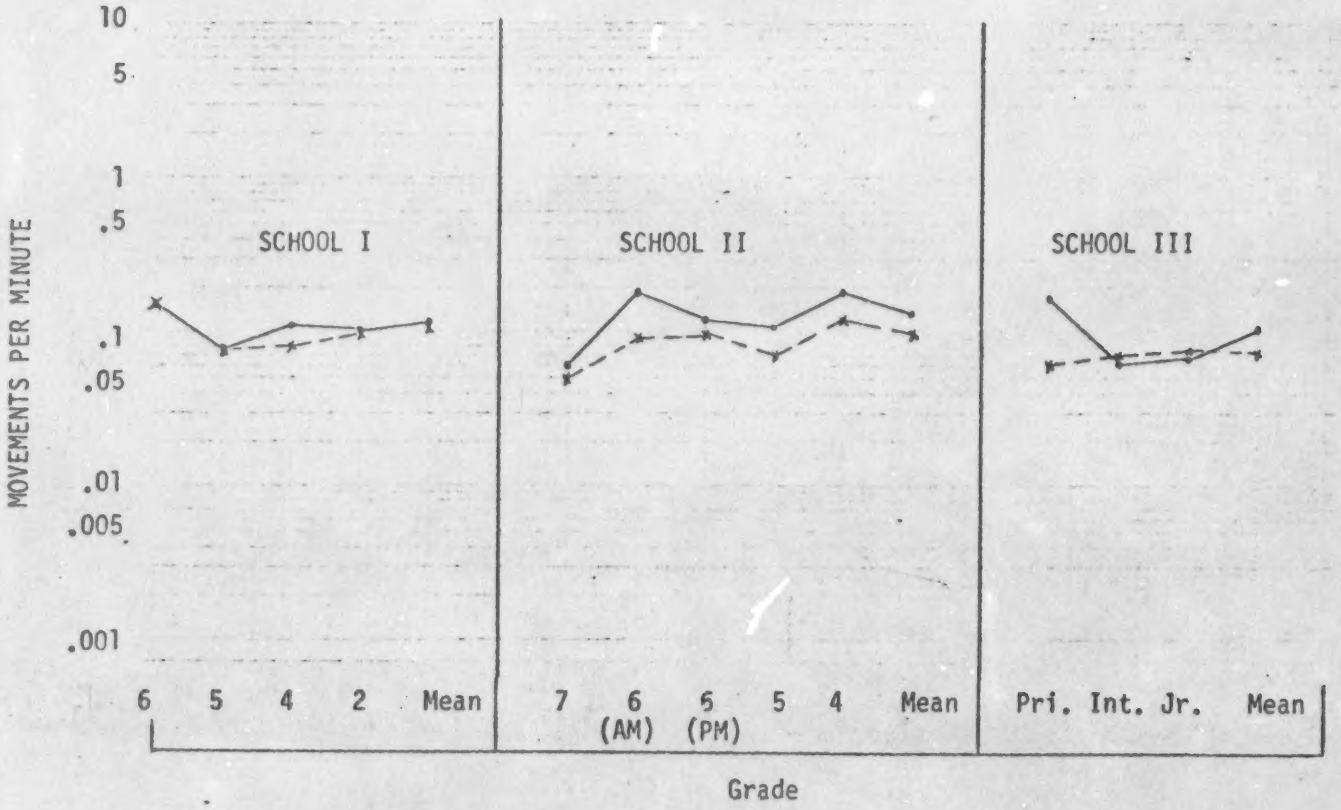


TABLE 3

Student-concrete Physical Environment Interactions Per Minute in School I by Observation Day, Grade, and "Old" or "New" Environment

| Observation Day | "Old" Environment | | | | | "New" Environment | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Grade | | | | | Grade | | | | |
| | 6 | 5 | 4 | 2 | Mean | 6 | 5 | 4 | 2 | Mean |
| 1 | .385 | .077 | -- | .396 | .288 | .215 | .068 | .092 | .110 | .124 |
| 2 | .193 | .066 | .108 | .056 | .109 | .154 | .069 | .067 | .124 | .107 |
| 3 | .140 | .073 | .166 | .055 | .112 | .150 | .069 | .063 | .102 | .099 |
| 4 | .093 | .063 | .110 | .060 | .085 | .117 | .072 | .086 | .070 | .089 |
| 5 | .104 | .059 | .121 | .057 | .088 | .101 | .069 | .080 | .120 | .096 |
| 6 | .126 | .053 | .108 | .061 | .090 | .123 | .078 | .060 | .059 | .083 |
| 7 | .133 | .050 | .047 | .064 | .077 | .153 | .077 | .056 | .069 | .092 |
| 8 | .133 | .091 | .055 | .059 | .088 | | | | | |
| 9 | .120 | .069 | .122 | .065 | .097 | | | | | |
| Total | 1.427 | .601 | .837 | .873 | 1.034 | 1.013 | .502 | .504 | .653 | .690 |
| Mean | .159 | .075 | .112 | .105 | .123 | .151 | .078 | .078 | .099 | .105 |

TABLE 4

Student-concrete Physical Environment Interactions Per Minute in School II
by Observation Day, Grade, and "Old" or "New" Environment

| Observation Day | "Old" Environment | | | | | | "New" Environment | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grade | | | | | | Grade | | | | | |
| | 7 | 6 AM | 6 PM | 5 | 4 | Mean | 7 | 6 AM | 6 PM | 5 | 4 | Mean |
| 1 | .119 | .335 | .087 | -- | .139 | .173 | .031 | .105 | .099 | .043 | .211 | .102 |
| 2 | .076 | .118 | .151 | .102 | .102 | .114 | .069 | .093 | .111 | .108 | .083 | .106 |
| 3 | .038 | .145 | .149 | .078 | .156 | .117 | .034 | .098 | .094 | .049 | .125 | .084 |
| 4 | .042 | .225 | .135 | .076 | .185 | .137 | .033 | .119 | .094 | .068 | .124 | .092 |
| 5 | .060 | .202 | .164 | .150 | .173 | .154 | .029 | .065 | .054 | .060 | .093 | .064 |
| 6 | .031 | .131 | .145 | .127 | .156 | .122 | .053 | .062 | .130 | .061 | .173 | .100 |
| 7 | .018 | .141 | .094 | -- | .395 | .165 | .042 | .064 | .099 | .078 | .126 | .086 |
| Total | .384 | 1.297 | .925 | .533 | 1.306 | .982 | .301 | .606 | .681 | .467 | .935 | .634 |
| Mean | .061 | .191 | .138 | .111 | .193 | .146 | .049 | .093 | .097 | .073 | .140 | .097 |

A decreasing direction for student-concrete physical environment interactions also occurred for School II but at the .01 level of significance (Table 5).

TABLE 5

Student-Concrete Physical Environment Interactions Per Minute in School III by Observation Day, Grade, and "Old" or "New" Environment

| Observation Day | "Old" Environment | | | | "New" Environment | | | |
|---|---|---|---|---|---|---|---|---|
| | Grade | | | | Grade | | | |
| | Primary | Inter. | Jr. H.S | Mean | Primary | Inter. | Jr. H.S. | Mean |
| 1 | .222 | .054 | .040 | .107 | -- | .046 | .061 | .055 |
| 2 | .124 | .067 | .076 | .091 | .154 | .094 | .106 | .120 |
| 3 | .079 | .063 | .050 | .066 | .053 | .064 | .064 | .062 |
| 4 | .078 | .040 | .054 | .059 | .035 | .052 | .083 | .059 |
| 5 | .106 | .062 | .049 | .074 | .049 | .055 | .024 | .045 |
| 6 | .506 | .045 | .059 | .207 | .035 | .063 | .054 | .053 |
| 7 | .068 | -- | .078 | .074 | .013 | .074 | .056 | .050 |
| 8 | | | | | -- | .057 | .098 | .088 |
| Total | 1.183 | .331 | .406 | .678 | .339 | .505 | .546 | .532 |
| Mean | .175 | .060 | .064 | .103 | .062 | .070 | .075 | .074 |

In order to determine whether significances occurred between different classroom units from different schools, the t-Test for matched pairs with uneven N was applied (Bruning, 1968). Results indicate that the hypothesis was accepted. It should be noted that significant differences did occur between School III - intermediate and School II - fifth grade in the "old" environment, and between School III - junior high school and School II - seventh grade in the "new" environment. All other analyses based on the difference between the grades and schools were insignificant. Of a total of twelve analyses made, it was somewhat surprising to find that two analyses reached an acceptable level of significance ($p < .01$ and $.05$).

These significant differences just for the two matched pairs defies a reasonable explanation; since the only basis for comparison was chronological age range. This could be an acceptable explanation, but the same two matched pairs showed no significant differences using the other analyses. A basic source of obfuscation for this data may have been a lack of having a ratio of student-concrete physical environment interactions to the total number of physical entities within each defined classroom environment. With a change from the "old" to the "new" environments, changes may have taken place in terms of the number of physical entities within the classroom; therefore, providing the opportunity or lack of opportunity to increase or decrease the inter-

actions between students and concrete physical environments.

Another component that may have confounded the results may have been in the actual recording of the research data. It is possible that "all systematic observation techniques suffer both from content limitations and from unreliability of the encoding process (Biddle, 1967, p. 50)." Possibly, motor behaviors should have been considered in context of the total days activities for subjects. Thus, observations could possibly have been done all day in one classroom. As Gellert (1955) points out, category observing may be criticized on the grounds that it "provides no checks on recording individual instances of behavior [and] it is inflexible and omits descriptive detail, thus divorcing acts from their context, and perhaps violating their meaning (p. 182)." While these considerations do have validity, it should be pointed out that the use of all statistics in this study are of an exploratory nature to help provide direction for more stringent investigations.

Test of Research Hypothesis Two

In order to test the research hypothesis that environmental preference by subjects will be non-significantly related to an environmental change based on responses received from the Response to Physical Environment Scale, a Complex Chi-Square was used to treat the statistical data (Bruning, 1968). Based on the total frequency of responses found in Table 6,

TABLE 6

Total Frequency of Responses to Response to Physical Environment Scale
by School and Grade Levels

| Grade | School I | | | | | | School II | | | | | | School III | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Old | | | New | | | Old | | | New | | | Old | | | New | | |
| | A | B | C | A | B | C | A | B | C | A | B | C | A | B | C | A | B | C |
| 2 | 61 | 59 | 96 | 86 | 42 | 88 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 4 | 95 | 28 | 111 | 66 | 20 | 148 | 28 | 29 | 51 | 18 | 11 | 79 | -- | -- | -- | -- | -- | -- |
| 5 | 93 | 29 | 112 | 75 | 29 | 130 | 53 | 26 | 128 | 60 | 28 | 119 | -- | -- | -- | -- | -- | -- |
| 6 | 77 | 41 | 149 | 74 | 20 | 173 | 64 | 37 | 97 | 67 | 37 | 94 | -- | -- | -- | -- | -- | -- |
| 7 | -- | -- | --- | -- | -- | --- | 49 | 18 | 68 | 31 | 6 | 98 | -- | -- | -- | -- | -- | -- |
| Pri. | -- | -- | --- | -- | -- | --- | -- | -- | -- | -- | -- | -- | 45 | 31 | 50 | 33 | 45 | 48 |
| Inter. | -- | -- | --- | -- | -- | --- | -- | -- | -- | -- | -- | -- | 46 | 27 | 44 | 42 | 17 | 58 |
| Jr. HS | -- | -- | --- | -- | -- | --- | -- | -- | -- | -- | -- | -- | 53 | 17 | 39 | 47 | 18 | 44 |
| Total | 326 | 157 | 468 | 301 | 111 | 539 | 194 | 110 | 344 | 176 | 82 | 390 | 144 | 75 | 133 | 122 | 80 | 150 |

a Complex Chi-Square was done by school districts.

For School I it was found that a change in environmental preference occurred significant at the .001 level. School II also showed a significant change ($p < .025$) in changing environmental preferences. For School III no significant ($p < .25$) change in environmental preference occurred (Table 7).

TABLE 7

Change of Environmental Preference [a]

| Group | Chi Square | df | Contingency Coefficient | p |
|---|---|---|---|---|
| School I | 13.8984 | 2 | 0.085 | .001 |
| School II | 7.8475 | 2 | 0.025 | .025 |
| School III | 2.9989 | 2 | 0.198 | .250 |

[a]Contingency tables in Appendix N

All changes of environmental preference as reflected by the responses made on the Response to Physical Environment Scale (Appendix D) went in the direction of the "new" open-concept environment. The direction of preference for subjects in School III was in a similar vain as Schools I and II but did not reach an acceptable level of significance ($p < .05$).
In all cases a shift occurred of having the "old" self-contained classroom becoming less desired with a change of environment (Table 6).

The changes in preference are strongly validated by the subjects' responses made on Your Feelings (Appendix K). For a composite percentage for all ten items on the Your Feelings instrument, 54.7% of the subjects' responses in School I preferred the "new" environment, while 24.6% preferred the "old" environment and 20.7% indicated that they felt the same about both environments. In School II a similar pattern existed with 46.4% preferring the "new" environment, while 34.0% preferred the "old" environment and 19.6% indicating no preference between the two environments. In School III 58.1% of the responses showed preference for the "new" environment, while 15.9% showed a preference for the "old" environment and 26.0% showed no preference for either one (Tables 8 and 9).

Caution is exercised in the interpretation of these findings. The direction that the preference took may be based on a completely independent frame of reference for the subjects in each school. The subjects in School I came from an old two-story structure which was part of the elementary-junior high school complex. From the "old" environment, they moved into a "new" open-concept environment (Appendix L). On the other hand subjects from School II moved into a "new" addition still attached to their previous "old" environment. The gym in the "old"

TABLE 8

Percentage of Responses Made by Subjects in Three Separate Schools for Each Item on Your Feelings

| Item (Number) | School I | | | School II | | | School III | | |
|---|---|---|---|---|---|---|---|---|---|
| | Old | New | Same | Old | New | Same | Old | New | Same |
| 1 | 12.6 | 70.8 | 16.6 | 27.5 | 45.0 | 27.5 | 5.3 | 92.0 | 2.7 |
| 2 | 33.1 | 34.0 | 32.0 | 35.0 | 50.0 | 15.0 | 22.7 | 36.0 | 41.3 |
| 3 | 17.9 | 68.9 | 13.2 | 45.0 | 40.0 | 15.0 | 12.0 | 54.7 | 33.3 |
| 4 | 4.5 | 70.8 | 20.7 | 37.5 | 47.5 | 15.0 | 12.0 | 66.7 | 21.3 |
| 5 | 25.5 | 50.0 | 74.5 | 17.5 | 60.0 | 22.5 | 22.7 | 42.7 | 34.6 |
| 6 | 31.1 | 30.2 | 38.7 | 10.0 | 50.0 | 40.0 | 17.3 | 45.3 | 37.4 |
| 7 | 6.6 | 82.0 | 11.4 | 50.0 | 22.5 | 27.5 | 9.3 | 86.5 | 4.2 |
| 8 | 22.6 | 40.6 | 37.7 | 40.0 | 27.5 | 32.5 | 16.0 | 20.0 | 64.0 |
| 9 | 55.7 | 22.6 | 21.7 | 17.5 | 45.0 | 37.5 | 32.0 | 32.0 | 36.0 |
| 10 | 14.2 | 74.5 | 11.3 | 35.0 | 42.5 | 22.5 | 8.0 | 84.0 | 8.0 |
| Total | 24.6 | 54.7 | 20.7 | 34.0 | 46.4 | 19.6 | 15.9 | 58.1 | 26.0 |

environment is still being utilized by the subjects. School III consisted of an "old" three-room school facility located on the outskirts of town. All interactions for these special education students in School III were mainly confined to this "old" (1913) environment. For the subjects in School III, the "new" environment still consisted of self-contained rectangular-shaped classrooms, but in a larger complex with other classrooms for special education students. Consequently, each school seems to reflect a different degree of environmental preference

TABLE 9

Total Responses to Your Feelings by Grade and School



| | School I | | | School II | | | School III | | |
|---|---|---|---|---|---|---|---|---|---|
| | Old | New | Same | Old | New | Same | Old | New | Same |
| 2 | 24.7 | 44.1 | 31.2 | -- | -- | -- | -- | -- | -- |
| 4 | 17.8 | 65.6 | 16.6 | 11.3 | 66.0 | 22.7 | -- | -- | -- |
| 5 | 23.5 | 55.8 | 20.7 | 14.4 | 65.4 | 20.2 | -- | -- | -- |
| 6 | 27.5 | 53.7 | 17.8 | 25.4 | 49.0 | 25.6 | -- | -- | -- |
| 7 | -- | -- | -- | 0.1 | 55.3 | 44.1 | -- | -- | -- |
| Pri.[a] | -- | -- | -- | -- | -- | -- | 32.9 | 52.3 | 14.9 |
| Int.[a] | -- | -- | -- | -- | -- | -- | 42.3 | 29.3 | 28.4 |
| Jr. H.S.[a] | -- | -- | -- | -- | -- | -- | 25.3 | 58.6 | 16.1 |

[a]Special education classes. Level designated by age

based possibly on the conceptual differences between the "old" and the "new" environments (Table 7). What this seems to point out is that "the behavior of different children within the same region was often more similar than the behavior of any of them in a different region (Barker, 1968, p. 152)."

Looking closer at Item 1 on Your Feelings which states, "It is the building that I like the best," it was found that subjects in all three schools expressed an overwhelming preference for the "new" environment (Table 8). This was

particularly evident for School III. This further cross-validates the direction of the responses made to the Response to Physical Environment Scale.

Based on the data, results indicate that the null hypothesis of environmental preference being non-significant with environmental change be rejected for Schools I and II and accepted for School III.

Test of Research Hypothesis Three

The DISTX (Spuck, 1971) computer program on product-moment correlations was applied to test the null hypothesis that student-concrete physical environment will show no significant relationship to: temperature, humidity, atmospheric pressure, sound level, or illumination level. Based on measures taken during one hundred, eighty-six observation sessions, it was found that a correlation existed between the frequency of student-concrete physical environment interactions and the following variables: mean temperature, temperature difference based on minimum-maximum thermometer readings, mean atmospheric pressure, mean illumination level, mean reflectance level, and the mean relative humidity (Table 10). All other variables showed non-significant relationships to student-concrete physical environment interactions.

Even though a number of variables correlated at significant levels, the r value tended to be somewhat small. The

TABLE 10

Mean, Standard Deviations for Selected Variables.
Variables Correlated with Total
Student-Concrete Physical
Environment Interaction [a]

| Variable | Mean | SD | r | z | p |
|---|---|---|---|---|---|
| Temperature Mean (TEMPM) | 73.895 | 2.367 | 0.249 | 3.386 | .001 |
| Temperature Difference (TEMPD) | 3.651 | 2.286 | -0.238 | 3.236 | .001 |
| Atmos. Pressure Mean (APM) | 29.914 | .375 | -0.211 | 2.869 | .002 |
| Atmos. Pressure Difference (APD) | .019 | .020 | -0.062 | 0.843 | NS |
| dB Mean-A Scale (DBAM) | 56.674 | 4.097 | -0.081 | 1.102 | NS |
| dB Mean-B Scale (DBBM) | 60.151 | 4.103 | -0.169 | 2.298 | .02 |
| dB Mean-C Scale (DBCM) | 66.593 | 3.455 | -0.117 | 1.591 | NS |
| Illumination Mean (ILLM) | 66.565 | 33.282 | -0.269 | 3.658 | .0003 |
| Reflectance Mean (REFM) | 19.785 | 14.172 | -0.216 | 2.938 | .003 |
| ILLM/REFM Ratio (L./RM) | 3.712 | .881 | 0.047 | 0.639 | NS |
| Relative Humidity Mean (RHM) | 36.758 | 8.899 | 0.151 | 2.054 | .04 |
| Relative Humidity Difference (RHD) | 5.043 | 5.190 | -0.101 | 1.374 | NS |
| DBAM-Ambient Mean, A Scale (A-AA) | 16.362 | 6.800 | 0.061 | 0.829 | NS |
| DBBM-Ambient Mean, B Scale (B-BB) | 12.445 | 7.099 | 0.017 | 0.231 | NS |
| DBCM-Ambient Mean, C Scale (C-CC) | 11.044 | 11.262 | -0.018 | 0.245 | NS |
| Interactions/Subject/Minute (TI/S/TB) | .096 | .060 | 1.000 | -- | -- |

[a] Complete table in Appendix P

temperature mean correlated at 0.249 (p .001) with student-concrete environment interaction. This result is somewhat contradictory to the results found in research literature. Possibly a minor change in the temperature of the environment can cause very minor changes in the internal

temperature of the body to consequently change the interaction levels of subjects (Harmon, 1951). On the other hand, the "presence of a correlation between two variables does not necessarily mean that there exists a causal link between them (Glass and Stanley, 1970, p. 121)." Due to the complexity of the social sciences, events cannot always be explained in terms of a single cause.

The temperature change (TEMPD) that occurred for the observation periods is negatively correlated (-0.238 at $p < .001$) with student-concrete environment interaction. Thus, the greater the temperature difference based on maximum-minimum temperature readings, the lower the frequency of student-concrete physical environment interactions.that exist. This interpretation has to be applied with a great deal of caution.due to the limited knowledge of the cause and effect relationship. If a relationship can be assumed, it could be an artifact of the teachers' responses to the temperature changes which consequently can have a changing impact on the instructional program, which in turn would negate the significance of this type of relationship. Perhaps if other variables were considered such as: metabolism, evaporation, convection, and radiation, a more effective interpretation could be made of the findings.

A low negative correlation resulted between atmospheric pressure means (APM) and student-concrete physical

environment interaction ($r = -0.211$ at $p < .002$). Yet no significant relationship existed between the changes in atmospheric pressure (APD) and level of student-concrete physical environment interaction. With a mean mercury fluctuation of 0.019 inches, it would suggest that the change was too minimal for the observations to be of any consequence.

Illumination and student-concrete physical environment interaction was found to be significant ($p < .0003$) and negatively (-0.269) related. Based on this finding, interactions should decrease with an increase in the level of illumination within an environment. This finding seems to contradict the assumption that if we want to increase the activity level of subjects, we need to merely increase the level of illumination (i.e., increase level of illumination to increase the physical activity of subjects in a gym or turning off the lights in a classroom to help the teacher "quiet" her students). Similar conjectures can be utilized in discussing the significant ($p < .003$), negative correlation between the mean reflected light (REFM) and student-concrete environment interaction.

A finding of interest was that no relationship existed between the brightness ratio (IM/RM) and that of student-concrete physical environment interaction. This may possibly suggest that the two previous relationships (ILLM and REFM) may be spurious in nature. It is possible that in a reflex action

subjects physically adapted their body geometry in order to center their positions to the brightness areas affecting their eyes without actually resulting in an increased student-concrete environment interaction (Harmon, 1946). Such results would suggest a need for further study which would consider additional lighting components such as source, distribution, color, and visual clutter which can increase or decrease visual efficiency and consequently the "readiness to act."

The relative humidity mean (RHM) for the observation sessions was found to be significantly related ($p < .04$) to student-concrete physical environment interaction. Even though the correlation was low ($r = 0.151$), it does reflect somewhat of an accurate relationship. Since relative hunidity is directly dependent on temperature, it seems to be somewhat congruent to the relationship between temperature mean and student-concrete physical environment interaction.

Sound level as reflected in the testing of the research hypothesis showed no significant relationship to student-concrete physical environment interaction. It is possible that the variance in sound level on all three scales was not great enough to elicit such overt actions that were considered to be student-concrete physical environment interactions. Confounding in the data recording could have resulted in the non-significant relationship. Since all sound

is directional, it is possible that the sound level readings actually reflected an inaccurate sound sample, since loudness varies with the distance from the sound source.

A similar inaccuracy may have existed in determining the difference between the mean sound level readings and the ambient sound level. Since the ambient sound varies with time of day, it would have been wholly inappropriate to consider it stable throughout the school when the other sound level readings were taken.

Furthermore, it is possible that sound level is a minor component of acoustics, and therefore should be considered with other factors such as noise transference, reverberation, and articulation as well as the originating source.

It is possible that "psychoacoustics" should be studied closer. The subjective reactions of subjects may be more meaningful than the observed overt behavior. Music seems to be pleasant for lunchrooms, and quiet often promotes a nap.

Further statistical analyses needs to be made between variables in Table 10 and other components such as "on-task" behavior and movement behavior within the classroom environment.

Test of Research Hypothesis Four

The null hypothesis stated that attending behavior would be non-significantly related to the change in physical environment. The t-Test for differences between means of paired observations was

applied to the frequency data acquired from the Draw-a-Classroom (Appendix G). The Draw-a-Classroom was administered to a total of two hundred seven subjects on two occasions (Appendix M). Administration of the instrument took place on the last week of observation while subjects were in the "old" environment and again when in the "new" environment. Consequently, pre and post-test data resulted for all but twenty-three subjects, who for some uncontrollable reasons did not receive two administrations of the Draw-a-Classroom.

Results based on the data indicate acceptance of the null hypothesis for Schools II and III and rejection of the null hypothesis for School I (Table 11). The results on the Draw-a-Classroom for School I show that a minus mean gain difference existed ($p < .05$). This would suggest that subjects responded with fewer physical items in the Draw-a-Classroom. These results may possibly reflect the attitudinal component of the open-concept environment that these subjects found themselves in. This is to say, that even though students clearly define the physical environment that belongs to them, they may not view the adjacent physical environment as the area that they should attend to.

Extreme caution must be taken in interpreting the findings for School I. The possibility exists that actually fewer physical items were located within the student defined area to which the experimental subjects could attend. Subjective

TABLE 11

Difference Between Means of Paired Observations on the Draw-a-Classroom

| Source | Mean gain difference | Gain difference | df | t | p |
|---|---|---|---|---|---|
| School I | -7.9805 | 35.3328 | 102 | -2.2923 | .05 |
| School II | 3.0447 | 31.2319 | 67 | 0.7979 | NS |
| School III | -3.7894 | 26.2649 | 37 | -0.8893 | NS |

TABLE 12

Comparison of Pairs of Mean On-task/Total Task Time Ratios

| Group | Old | New | t | p |
|---|---|---|---|---|
| School I | .425 | .403 | 1.9375 | .10 |
| School II | .403 | .397 | .3776 | NS |
| School III | .777 | .418 | 19.3826 | .001 |

observations are that no signifigant difference of the number of physical items in the environment existed. If any change did occur, it was in terms of increasing (new materials and equipment) physical entities in the environment. The notion stressed by Barker (1968), that a subject's behavior would often change dramatically when moved to a new environment is supported by the results for School I and negated by the results for Schools II and III. Possibly in Schools II and III the results of changing from the "old" environment to the "new" environments was not "dramatic" enough to cause a significant change in attending behavior to physical environment as reflected by the Draw-a-Classroom. It may be the situation that children reflect their beliefs, desires, feelings and fancies rather than objective reality (attending behavior to physical entities in the environment) as represented by the Draw-a-Classroom (Lowenfeld, 1962). The possibility also exists that for the subjects in School II, the time spent in the "new" environment was too short of a duration (three weeks) to have a significant impact on the attending behavior to physical entities included with the environment.

To assess attending behavior that possibly relates more directly to instruction, the direct observation of "on-task" behavior was used. Based on the teacher defined instructional objective for each observation period, cumulative "on-task" behavior time was recorded for the subjects. Applying a t-Test

for significance of difference between two sample means with uneven N (Winer, 1962, Bruining, 1968), results indicate the acceptance of the null hypothesis for Schools I and II and the rejection of the null hypothesis for School III (Table 12). Based on the findings, the assumption that the "new" environment enhances learning ("on-task" behavior) is not supported. In Schools I and II no significant change occurred that would indicate a change in the "on-task" to total task time ratios.

For School III a significant ($p < .001$) change occurred but in a negative direction. In School III on-task behavior actually decreased. This may in effect be caused by the additional distracting components that are inherited when classroom units move from a three-room school to a much larger complex with more classroom units.

From the results it can be concluded that there exists more than one type of attending behavior, which are not necessarily correlated and defy simplistic explanations. This seems to be in line with the generalization made by Barker (1968) that "...units of environmental input and units of behavior are not regularly coupled and congruent,...(p. 148)."

Test of Research Hypothesis Five

The last hypothesis to be tested was to determine whether student movement within the classroom will be non-significantly related to a change in physical environment.

The analysis of the data was based on the movements per

minute from quadrant to quadrant as derived from the Behavior Analysis Quadrant instrument (Appendix H). Again, utilizing the t-Test for the difference between two sample means with unequal observations, results indicate the rejection of the null hypothesis for School I at $p < .05$ and the acceptance of the null hypothesis for Schools II and III (Table 13).

TABLE 13

Comparison of Pairs of Mean Q to Q Movements Per Minute

| Group | Old | New | t | p |
|---|---|---|---|---|
| School I | .499 | .829 | 2.2688 | .05 |
| School II | .461 | .687 | 1.4762 | NS |
| School III | .440 | .538 | 1.3088 | NS |

It should be recalled that the subjects in School I moved from an "old" self-contained rectangular-shaped classroom facilities to a "new" open-concept environment. Consequently the entire task surround was changed--lower ceilings, no walls, less territorially defined area, etc.... The significant increase in movement from quadrant to quadrant may reflect the hypothesized "correlation between the form of a spatial enclosure and the reactions to it by some form of muscular tension (Leonard, 1969)." Conversely, these movements may reflect the expectation of the teachers, if you have such a big carpeted open space, why not let

the youngster move around.

The task surrounds did not dramatically change for Schools II and III, consequently the possibility exists that no significant change in frequency of quadrant to quadrant movements was noted. The similarity of the "old" and "new" environments may reflect a resulting congruence in movement behavior in the "old" and "new" environments (Barker, 1968). This assumption seems to concur with Kyzar(1962), who found that the utilization of classroom floor space was not significantly influenced by classroom design. Hall (1969) indicates that the space "that permits the greater variety of movement will usually be experienced as larger (p. 53)." Conversely, it may be possible that the space (open-concept) that is perceived as larger will cause movement behavior to increase or provide subjects with a greater freedom of choice (Proshansky, 1971).

An alternate explanation may be that the significant movement behavior in School I was a result of attempting to increase interaction distance between subjects as part of an avoidance pattern that was established. This avoidance pattern may have been the result of eliminating individual stations, but instead utilizing tables, which lacked territoriality and privacy (Sommer, 1969).

Is it then possible that student quadrant to quadrant movement is related to "on-task" behavior? Applying Pearson's product-moment correlation, no significant relation was found for

any of the environments (Table 14). Thus, again suggesting that there seems to be some significant relationship between the type of designed environment and the quadrant to quadrant movement patterns. Possibly a correlation may exist between the space covered and the number of activities per unit of time as was found in an earlier study by Barker (1929).

TABLE 14

Correlations of Attending Behavior with Student Movement Behavior

| Source | N | r | p |
|---|---|---|---|
| School I - "Old" | 35 | 0.1848 | NS |
| School I - "New" | 28 | 0.3228 | NS |
| School II - "Old" | 33 | 0.0043 | NS |
| School II - "New" | 29 | 0.2309 | NS |
| School III - "Old" | 20 | 0.0194 | NS |
| School III - "New" | 22 | -0.2426 | NS |

Testing for the Effects of Change

A number of procedural steps were taken in this investigation to determine whether the Hawthorne effect resulted in behavior changes with an environmental change.

The behavioral data taken on the first week of observations in the "new" environments showed non-significant differences to the data acquired on subsequent weeks. This is exemplified by the charted results on the mean student-concrete physical environment

interactions in Figure 4, 5, and 6. Similar non-significant differences resulted for the "on-task" behavior data.

The same comparison was made between the last week of observation and the others, again differences were non-significant. Thus, on this index of comparison, no significant change occurred in the observed behavior of the experimental subjects as a result of the change or as a result of the observer's presence within the environment.

By utilizing the Impact of Facilities Scale with teachers from all three schools, observations were made to determine whether their change in expectations was due to the change in environments (Appendix J).

Through the use of analysis of variance, treatment-by-subjects, a test for significance was made on the mean teacher responses for each school (Winer, 1962, Bruning, 1968).

The teachers from School I showed no significant change in expectations (Table 15). Subjects in Schools II and III showed a significant ($p < .001$) change in expectations (Tables 16 and 17).

TABLE 15

Comparison of Responses Made by Same Teachers in School I on the IFS in "Old" and "New" Environments

| Source | SS | df | MS | F | p |
|---|---|---|---|---|---|
| Total | 4,931 | 103 | -- | -- | -- |
| Subjects | 2,663 | 51 | -- | -- | -- |
| Treatments | 50 | 1 | 50.0 | 1.15 | NS |
| Error | 2,218 | 51 | 43.5 | -- | -- |

Fig. 4. - Total mean student-concrete physical environment interaction for School I in "old" and "new" environments

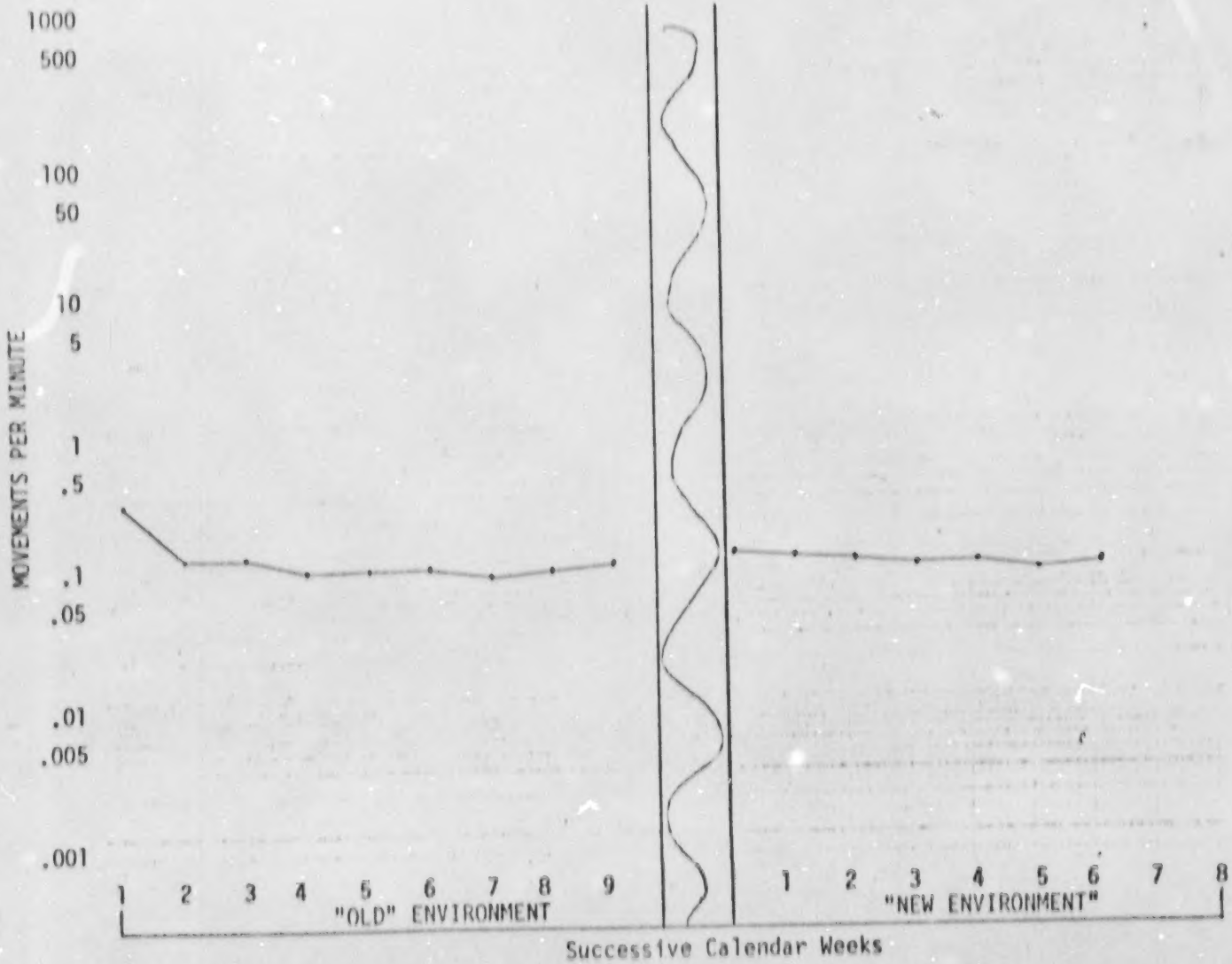


Fig. 5. - Total mean student-concrete physical environment interaction for School II in "old" and "new" environments

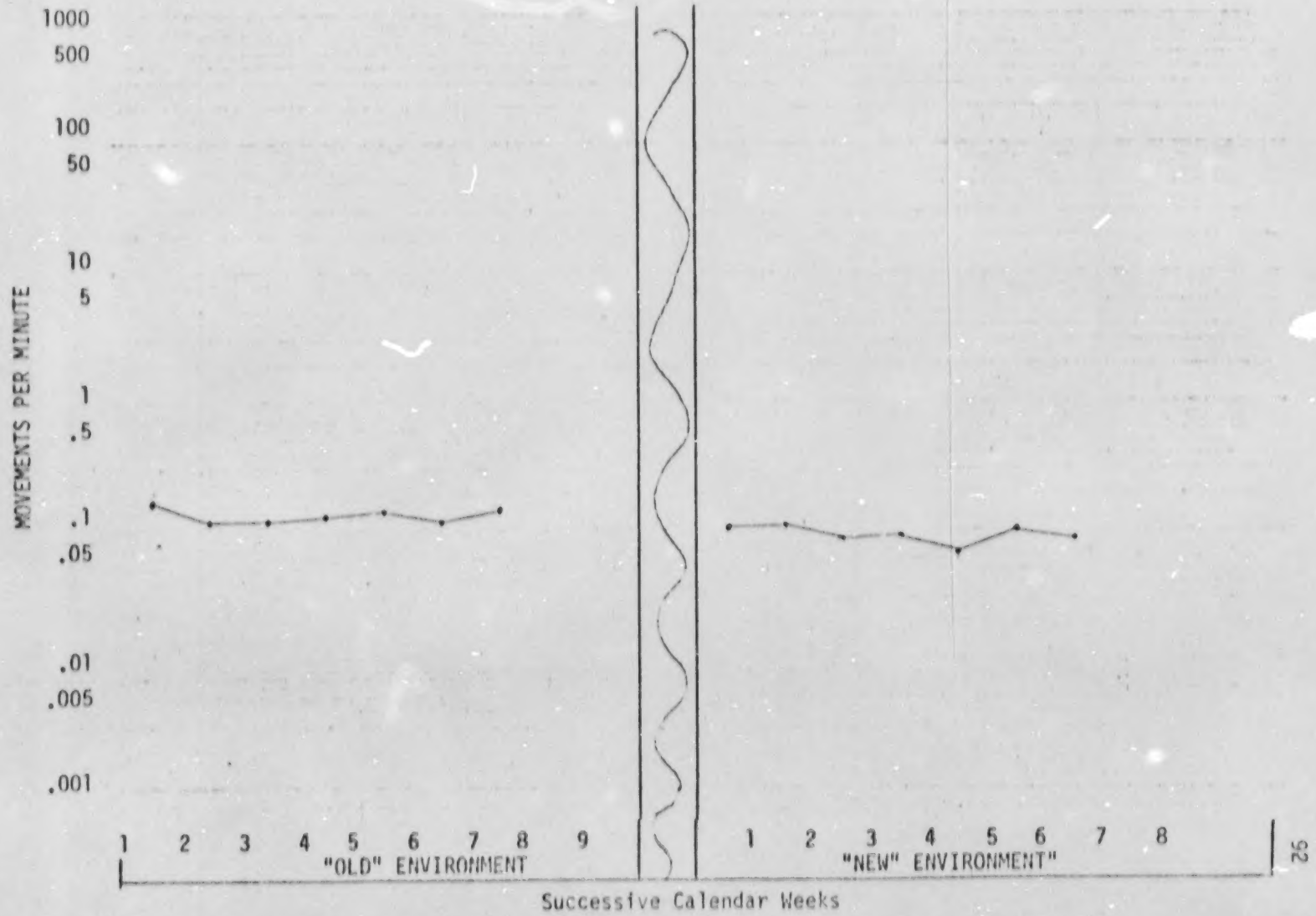


Fig. 6. - Total mean student-concrete physical environment interaction for School III in "old" and "new" environments

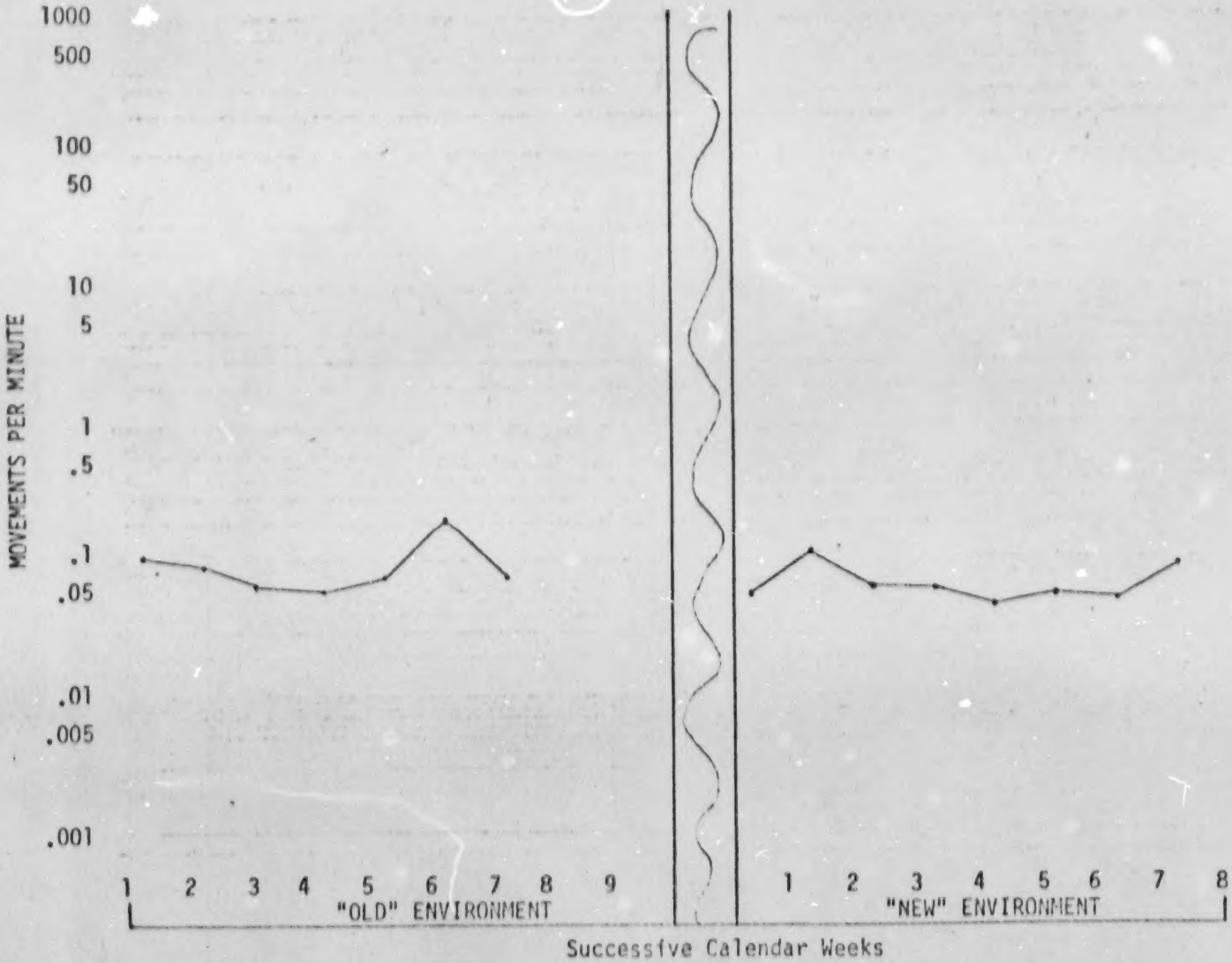


TABLE 16

Comparison of Responses Made by Same Teachers in School II on the IFS in "Old" and "New" Environments

| Source | SS | df | MS | F | p |
|---|---|---|---|---|---|
| Total | 7,598 | 103 | -- | -- | -- |
| Subjects | 6,662 | 51 | -- | -- | -- |
| Treatments | 347 | 1 | 347 | 30.2 | .001 |
| Error | 589 | 51 | 11.5 | -- | -- |

TABLE 17

Comparison of Responses Made by Same Teachers in School III on the IFS in "Old" and "New" Environments

| Source | SS | df | MS | F | p |
|---|---|---|---|---|---|
| Total | 4,280 | 103 | -- | -- | -- |
| Subjects | 3,572 | 51 | -- | -- | -- |
| Treatments | 256 | 1 | 256 | 28.8 | .001 |
| Error | 452 | 51 | 8.9 | -- | -- |

A number of interpretations are offered for these findings. In School I where no significant change occurred, the teachers were continually pre-serviced regarding the development of the educational specifications for the "new" facility. Consequently they may have realistically viewed what was going to happen. Thus, their perceived expectations were closely related to the real behaviors as indicated by the Impact of Facilities Scale.

In Schools II and III the teacher involvement in the development of the educational specifications was minimal. As a result a significant discrepancy occurred between their perceived expectations of certain behaviors and the real behaviors exhibited in the new environment.

The results may also be symptomatic of group attitudes in regards to the study itself. By allowing the name option, a skewing of responses could have occurred. Anonymity is not always congruent with honesty.

Conversely, the instrument itself may be lacking in predictive validity. Even though items on each form of the instrument have face validity and an acceptable overall reliability, the grammatical tense of the items between the two forms of the instrument may have actually resulted in two separate instruments. Consequently a great need exists to further test the reliability and determine the instrument's predictive validity.

# Chapter IV

## Summary and Implications

"...man learns while he sees [feels, hears, tastes, smells] and what he learns influences what he sees [feels, hears, tastes, smells] (Hall, 1969, p. 66)." This exploratory study tested selected variables to determine the effects of physical environment on children's behavior in the classroom. In its attempt it used a small portion of the IS-DOES formula coined by Ogden Lindsley. "The IS part of the formula is intended to include all of the various kinds of things which exist in the individual's environment, while the DOES part of the formula is identical in structure, except that it is composed of those events which have been identified as having an effect upon the pinpointed behavior (Bradfield, 1970, p. 25)."

This study has accomplished a very small portion of both factors in the IS-DOES formula.

### The Problem

The purpose of this study was to explore the effects of selected physical environmental variables on children's behavior in the classroom. Specifically a test was made on the following five null hypotheses:

1. No significant difference in the relationship of student-concrete physical environment interaction to to the physical environment will occur with a change of

physical environment.

2. Environmental preference by students will be non-significantly related to an environmental change.
3. Student-concrete physical environment interaction will show no significant relationship to: temperature, humidity, atmospheric pressure, sound level or illumination level.
4. Student attending behavior will be non-significantly related to a change in physical environment.
5. Student movement behavior within the classroom will be non-significantly related to a change in physical environment.

## Population

The experimental subjects in the study consisted of two hundred thirty elementary and junior high school age students from eleven different classrooms in three schools, with each school being from a separate school district in Wisconsin. All subjects included in the study came from classroom units that met the following criteria: 1) school district in a building program, 2) classroom units moving into "new" facilities in the early part of the second semester, 3) grouping and composition within classrooms staying intact, 4) teachers continuing with same groups, 5) class time schedule remaining approximately the same and 6) no significant changes in instructional approaches to occur.

These same experimental subjects were employed as their own controls in testing the research hypotheses.

Data Gathering Procedures

All data recording and collecting procedures deployed in this study were made through in-classroom visitation and observation. The data collected for research Hypothesis One consisted of the rate of student-concrete physical environment interactions for each observational period.

For research Hypothesis Two the Response to Physical Environment Scale was utilized. This instrument was administered as a pre-test and post-test to two-hundred and twenty subjects on the last observation week in the "old" and "new" environments. This instrument provided data on the change of environmental preference as indicated by subjects' responses to picture triads reflecting "different" age and types of classroom environments.

To test research Hypothesis Three, numerous measurements were taken in order to have a sufficient data base for analysis. In addition to making use of the student-concrete physical environment interaction data collected for research Hypothesis One, a number of other measures were taken over a period of one-hundred and eighty-six observations. The other measures taken included: four temperature readings per observation period, two relative humidity readings per observation period, two atmospheric pressure readings per observation period, sound level readings at five minute intervals and four level of illumination

readings per observation period.

Two separate instruments were utilized to acquire the necessary data to test research Hypothesis Four on the change of attending behavior with a change in the physical environment. The Draw-a-Classroom instrument was used to determine the frequency of attending behavior to physical entities within the classroom. This instrument was administered as a pre-test and post-test to two-hundred and seven subjects on the last observation week while in the "old" and "new" environments. The other instrument or technique utilized to determine the duration of attending ("on-task") behavior was by direct observation. With a stopwatch a cumulative "on-task" behavior time was derived for all subjects within each classroom environment for any given observational period. Consequently, an "on-task" behavior time per subject per minute resulted for each observation period.

To test research Hypothesis Four, the data acquired from the Behavior Quadrant Analysis was used. On this instrument, locational and directional notations were marked at each five minute interval for all subjects located within a classroom environment. As a result, a total frequency of quadrant to quadrant movement behavior occurred. The same procedure being employed in all eleven classrooms both in "old" and "new" environments.

In order to determine a possible Hawthorne affect due to the change itself, from an "old" to a "new" environment, the Impact of Facilities Scale was utilized on pre and post-test basis with

twenty-six teachers who were actually involved in the physical move. On the pre-test form of the instrument it elicited teacher responses predictive of what behavioral changes would occur in the "new" environment. On the post-test respondents indicated actually what behavior did occur. The discrepancy between pre and post-measures was interpreted as the effect of change.

In addition to the data derived from the Impact of Facilities Scale, comparisons were made on the student-concrete physical environment interactions and "on-task" behavior from the first and last observation sessions with the other sessions. This provided a comparative index as to whether the change itself or the observer in the classroom caused significant changes in behavior.

For general overall validation, the Your Feelings instrument was administered to two-hundred twenty-one subjects. This provided the study with data on subjects' personal feelings when comparing the "old" and "new" environments on ten generalized behavior variables.

## Data Treatment Procedures

Significant differences of student-concrete physical environment was analyzed using analysis of variance, repeated measures, with Scheffe's approximation for unbalanced designs. In order to look at each school independently, the t-Test between differences of means between two matched samples with unequal N

was executed.

To determine the significance of changes in preferences with a change in environment, the Complex-Chi-Square was done for each school independently. To provide cross-validation, the percentages derived from Your Feelings were compared to determine direction trend preferences.

Pearson product-moment correlations were computed for the variables in Hypothesis Three. Based on N the level of significance was determined for each correlation.

To analyze the data on attending behavior for research Hypothesis Four, two separate statistical treatments were necessary. On the pre-test and post-test measures for the Draw-a-Classroom, the t-Test for the differences between means of paired observations were applied for each school included in the study. The t-Test for significance of differences between two sample means with uneven N was applied to "on-task" behavior time between the "old" and "new" environments.

Again, the t-Test for the difference between two sample means was applied to the movement behavior data acquired in testing research Hypothesis Five.

Finally, to consider the Hawthorne effect, the repeated measures of analysis of variance design was used to treat the data obtained from the Impact of Facilities Scale. In conjunction with this problem percentages were computed for Your Feelings.

## Results

No significant difference of student-concrete physical environment interaction occurred with a change in physical environment. When a t-Test for differences between means of two matched samples with unequal N was applied, a significant ($p < .01$) change occurred for School II. The other schools showed no significant changes. A comparison between classroom units from the three schools showed significant differences between School III - intermediate level and School II - fifth grade ($p < .01$), and between School III - junior high school level and School II - seventh grade ($p < .05$). No other significant differences were indicated.

Environmental preference by students will be non-significant with an environment change was rejected for School I and accepted for Schools II and III. The direction of changes in environmental preference was strongly validated by the results from Your Feelings.

Mixed results are indicated on the relationships between student-concrete environment interaction and the variables of temperature, humidity, atmospheric pressure, sound level and illumination level. Low correlations seem to exist, but at significant levels, for mean temperature ($r=0.249$, $p < .001$), maximum-minimum temperature difference ($r=-0.238$, $p < .001$), mean atmospheric pressure ($r=-0.211$, $p < .002$), mean illumination level ($r=-0.269$, $p < .0003$), mean reflectance level ($r=-0.216$, $p < .003$)

and mean relative humidity ($r=0.151$, $p<.04$).

Based on the pre and post-test scores from the Draw-a-Classroom, the research hypothesis that student attending behavior will be non-significant with a change in physical environment is accepted for School II and III and rejected for School I. On the mean "on-task" to total task time ratios all Schools showed a decrease in attending behavior, but School III only reached an acceptable level of significance ($p<.001$).

Student-movement within the classrooms with a change in physical environment was found to be significant ($p<.05$) for School I and insignificant for Schools II and III.

In relation to change in expectations as reflected by the Impact of Facilities instrument, School I showed no significant change, while respondents in Schools II and III showed a significant ($p<.001$) change.

The results uncovered no clear trends, but did yield some additional insight into the complexity of the interactions between physical environment and human behavior.

## IMPLICATIONS FOR EDUCATIONAL ENVIRONMENTS

Based on the research data and the researcher's own observations, the following implications for educational environmental engineering are presented:

1. Consideration for the proper props should be recognized. A determination must be made whether these props are conducive, coersive or even detrimental to student learning. It is of interest to note that tables were utilized in greater frequency in the "new" environments. Yet, individual study stations are generally preferred by students over tables. A strong possibility seems to exist that children need a place with which to identify and call their own. Furthermore, tables have a tendency to destroy or reduce a student's personal space and territoriality. In addition they act as unintentional behavior controlling devices. Consequently, if tables are to be utilized in the classroom settings, efforts should be made to determine the psychological ramifications they have on student behavior. It is suggested that one not be abandoned for the other. Both should be used judiciously to enhance or modify desired student behaviors.

2. More attention should be paid to activities that are implemented on carpeted spaces. In this study it was noted that carpeted floors were utilized more frequently as a work area than non-carpeted floors. The frequency seemed the greatest with the youngest students. Of special significance, was that the "regular" elementary students (Grade two) tended to actually utilize the floor as a work space, while the special education youngsters (Primary) seemed to consider the carpeted floor as a play area. This may suggest that a closer look be given to the functionality of carpeted floors for various learning activities. It was further noted that teachers tend to sit on carpeted floors with their students. This was never observed when teachers were in rooms that had tiled or wood floors. Thus, in reality student use of carpeted floors may simply reflect a modeling effect. It would not be surprising to find that children would utilize "any" floor as a work space if it were considered "proper." Of course this would imply that tile and wood floors need to be cleaned as frequently as carpets are vacuumed. In continuing to use carpeted floors as a work area, it may be advisable to utilize low profile furniture (legs shortened) and

bean bag chairs. At least, this would somewhat tend to reduce postural stress when doing such tasks as writing.

3. In two of the facilities, flexibility of space was considered in the educational specifications. In School I, the instructional area under study consisted of one open space (148'x200'). It was of interest to note that teachers utilized book carts and bookcases to delineate "their" environments. A similar situation persisted in School II. Based on observations, flexibility of instructional space simply seems to be educational jargon. Not only is the defined space inflexible, but what's in it remains stationary. Generally, furniture is not moved unless students are directed to do so by their teachers. Thus, human perceptions have to be restructured if instructional space is to have flexibility. Perceptual restructuring could possibly occur through in-service as well as through administrative mandate to manipulate environments based on different instructional approaches (i.e., team teaching). Again different color masking tape on the floors could facilitate and engender perceptual flexibility of instructional approaches. Why not outline classroom floors the same way we outline gym floors in order to structure certain activity patterns in students?

5. Man needs a changing environment to function most effectively. In our school facilities we should exercise greater control on these changes in order to maximize learning. Light, sound and temperature control should be coordinated to the classroom schedule. The lights should approximate the natural light spectra. Furthermore, the lights should be controlled by rheostats which would allow the intensity to be coordinated with the classrooms schedule of activity. Sound levels could be controlled by increasing or decreasing white noise or by even providing localized fire proofed drop curtains which could muffle undesirable sound. At the same time these curtains could provide territoriality to the classroom unit. Temperature should be schedule coordinated (based on activities) using automatic temperature, humidity and air velocity regulating equipment. Consequently this control could be used to maintain optimal student metabolism in any given classroom environment.
6. Heating and cooling units, if roof mounted, should be located over a non-academic instructional area. If unit is not roof mounted, it should be encased in an independent enclosure. This would tend to reduce the

ambient sound level, therefore reduce the audibility threshold necessary for hearing. This would consequently lower the general sound level in the environment.

7. Walls should be covered with fabric (i.e., vinyl). This would allow students the opportunity to use the whole wall (floor to ceiling) for instructional purposes. Major concerns for the school plant designer should be what can the wall do for the child, and what can the child do with the wall.
8. Utilize halls as instructional areas. Put mosaic footprints on floors and handprints on walls. Other visuals (i.e., multiplication tables on walls, star formations on ceilings, mirrors on walls, etc...) should be abundantly displayed. Clothes hangers and lockers should be color and number coded so they are visible at a distance. Why not utilize things that stimulate children in the classroom in the void of the halls? Learning should be continuous. If we change the task surround, we may change behavior drastically.
9. Accelerate the re-integration of special education students into the regular class environment. Research data indicates that no significant difference seems to exist between special education students'

behavior and that of the "regular" student on student-concrete physical environment interaction and "on-task" behavior. This would further raise doubt on the efficacy of special education classes. Other Other worthy results comparing special education students and "regular" students seem to be as follows:

a. Special education students indicated that they paid better attention to tasks in the "old" environment, even though they liked the "new" environment at a higher percentage than the "normal" students. This may reflect the disruptive component of having a larger number of classrooms within a given facility. It is possible that habituation does not come quite as rapidly to special education students as it does with "normal" students. Consequently, pods may work well with these students.

b. It is of interest to note that on the composite percentage score on Your Feelings, the intermediate special education students preferred the "old" over the "new" environment. This may suggest that each classroom be treated as a single responding organism when doing facility evaluations.

c. Special education students show the greatest mean increase in deviant behavior when moved to the "new" environment. This may reflect greater

ambiguity to "new" environmental patterns, consequently resulting in more adjustment problems. Thus, possibly indicating a need for a longer adjustment period for special education students. This may be alleviated by in-servicing students on their new facilities. It may be even advantageous to consult with the students when developing the educational specifications for new facilities.

d. Special education students show the lowest mean quadrant to quadrant movement in both "old" and "new" environments. Even though there was an increase in the movement behavior in the "new" facilities, special education students show the smallest decrement. This again may reflect the students' adjustment pattern to "new" environments.

e. Special education students showed a greater frequency of student to student contact. This may suggest greater aggressiveness or some social deprevation. Both of which can be overcome somewhat by increasing distance between students within a structured socially acceptable milieu.

10. Implement Harmon's Coordinated Classroom concepts in existing school facilities.

11. Training teachers in the art and science of environmental manipulation can improve the efficiency and effectiveness of teaching and learning.

## Implications for Further Research

This investigation should be viewed only as an initial attempt to explore the relationship between physical environment and human action and interaction. The results, even though suggestive that some behavioral changes occur with a change in physical environment, are not conclusive. Based on the results of this investigation, the following implications for further research are presented:

1. Video equipment should be utilized to record student movement and interaction within a defined classroom environment. This would allow the researcher more precise method for analyzing the majority of the overt behaviors that occur within the environment.
2. Body motion and movements should be looked at closer. Analysis may be based on Hall's (1959) proxemics or Birdwhistel's (1970) kinesics. To supplement these data, the possible modification of a pedometer could be made, which could then be utilized to indicate the frequency and strength of physical activity. The activity level could be further indexed by having subjects wear adapted self-winding wristwatches (Schulman, 1959) which could record the amount of movement under different environmental conditions.
3. Utilize a hodometer (Bechtel, 1967) under the carpeting or tile within "new" classroom environments.

This would provide researchers with empirical data as to what areas of the physical space were used most frequently. In addition, it could possibly indicate how the frequency of space utilization changes with curricula, activity changes and preferences for concrete-physical entities.

4. Expand the validation and reliability study of the instruments that were utilized in the study. Of special significance for long-term study would be the determination of the instruments' predictive validity.
5. Develop and utilize three dimensional photographs based on the Response to Physical Environment Scale which could be viewed on the 3-D Viewlex viewer. This would provide respondents with a more realistic and representational view of the different classroom physical environments that are to be considered for analysis.
6. Utilize more sophisticated electronic monitoring equipment within the classroom environment. This should provide the researcher with a continuous graphic record for the following variables: temperature, humidity, atmospheric pressure, air movement, illumination levels and sound levels. Consequently, the results from continuous monitoring could be correlated more effectively with subject activity behaviors. By taking

simultaneous continuous measures at different locations within the classroom environment, contour mapping could result, which could be related to student behaviors.

7. With the aid of time-lapse photography the quadrant to quadrant movement could be more accurately recorded and analyzed.

8. The Draw-a-Classroom instrument should be further explored. In addition to quantitative analysis of physical components included in the drawings, qualitative analysis should be made. The validation of qualitative aspects of the drawings could be on the same basis as for other projective techniques. Extension of the scoring system may be possible by using unobstrusive measures (i.e., weight of the carbon on the paper, number of lines, total length of all lines on a drawing, etc...).

9. Utilize an instrument similar to the Impact of Facilities Scale with students, parents, architects, maintenance personnel and administrators. A possibility exists that this type of instrument could provide us with a Behavior Expectancy Index. Based on such an index, environmental engineering could be initiated which would modify student reaction, action and interaction.

10. Expand Flanders Interaction Analysis to include physical environment. This would allow investigators the

opportunity to view physical environment within a complete social and physical interaction matrix. Consequently, providing the opportunity to analyze physical environmental interaction within the context of the social milieu.

11. Explore the development and utilization of an Environmental Gestalt Index. This index would represent components from the molar environment (some of these components were found to be significant in the present research). If this index was found to be of merit, it could be utilized to predict human behavior under conditions specified by the index.
12. Analyze attendance patterns as they relate to environmental change.
13. Determine if a relationship exists between recorded behavior variables and subjects' cultural, educational and socio-economic level.
14. Utilize a concentrated observational technique, by recording behavioral data for one group of subjects over an extended period in both "old" and "new" environments. This type of approach would take into consideration the changing context in which the behaviors are occurring.
15. Extend the research design of this investigation. This would require that subjects be moved back to the "old"

environment. Thus, if behaviors change to the levels that were previously exhibited in the "old" environment, it would denote that the physical environment was the actual change agent.

16. Implement a longitudinal study of the possible effects the "new" environment may have on achievement performance and "self-concept" of school age subjects.
17. Finally, make a follow-up study based on this investigation. This may provide data regarding the constancy of behaviors in the "new" environments.

Epilogue

There are truly two teachers in each classroom environment. Both requiring further study as to how they affect children's behavior and learning.

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APPENDIX A

Population

| Grade | School No. 1 South Park Elem. (Oshkosh) | School No. 2 Nashotah-Delafield | School No. 3 Grant School (West DePere) | |
|---|---|---|---|---|
| 2 | 27 | -- | -- | |
| 4 | 26 | 14 | -- | |
| 5 | 28 | 25 | -- | |
| 6 | 30 | 22 | -- | |
| 7 | -- | 18 | -- | |
| Pri. Sp. Ed. * | -- | -- | 14 | |
| Interm. Sp. Ed. * | -- | -- | 13 | |
| Jr. High School Sp. Ed.* | -- | -- | 13 | |
| Total | 111 | 79 | 40 | 230 |

*Special education classes for educable mentally retarded children

APPENDIX B

Observations: Grade, Time, Sessions and Mean Duration

| School | Grade | | Time | | Number of Sessions | | Mean No. of Min. of Observ. (Actual) | |
|---|---|---|---|---|---|---|---|---|
| | Old | New | Old | New | Old | New | Old | New |
| I | 2 | 2 | P.M. | P.M. | 9 | 7 | 39.9 | 31.4 |
| I | 4 | 4 | A.M. | A.M. | 8 | 7 | 24.2 | 33.7 |
| I | 4 | * | P.M. | * | 6 | * | 25.4 | * |
| I | 5 | 5 | A.M. | A.M. | 9 | 7 | 39.1 | 38.6 |
| I | 6 | 6 | A.M. | A.M. | 9 | 7 | 22.2 | 22.1 |
| II | 4 | 4 | A.M. | A.M. | 7 | 7 | 17.0 | 20.8 |
| II | 5 | * | A.M. | * | 7 | * | 30.9 | * |
| II | 5 | 5 | P.M. | P.M. | 5 | 7 | 23.1 | 38.6 |
| II | 6 | 6 | A.M. | A.M. | 7 | 7 | 17.3 | 29.4 |
| II | 6 | 6 | P.M. | P.M. | 7 | 7 | 20.3 | 27.9 |
| II | 7 | 7 | A.M. | A.M. | 7 | 7 | 37.1 | 43.9 |
| III | Pri. | Pri. | A.M. | A.M. | 7 | 6 | 29.8 | 43.3 |
| III | Int. | Int. | P.M. | P.M. | 6 | 8 | 39.6 | 39.0 |
| III | Jr.H. | Jr.H. | A.M. | A.M. | 7 | 8 | 42.8 | 36.8 |

*Schedule changes necessitated the deletion of these observation time blocks from the study.

# APPENDIX C

## Student-Concrete Physical Environment Interaction Instrument

### Use

The Student-Concrete Physical Environment Interaction-Instrument is utilized to determine the amount and types of interaction subjects exhibit in a classroom setting.

### General Directions

In order to determine the rate of student-concrete physical environment interaction, an objective observational technique is to be used.

### Specific Directions

Begin observing subjects in the first row from the left when facing class. When students are not in definitive rows, start with the nearest and go to the next closest and so on.

Rate a different student for each successive thirty-second period (use a stopwatch for accuracy). Whenever a subject makes physical contact with any item in the five categories listed below, record it on a manually operated portable multi-unit digital counter. Record only interactions that are of a two-second minimum duration which have a definable beginning and end. In addition the interaction should be able to pass the dead man's test. That is, if a dead man can do it, don't count it. All interactions should be independently recorded after resumption of physical contact, even with repeated interruptions.

Concrete Physical Environment Categories

Human Contact (HC)

1. student student
2. student teacher

Immovable Structures (I)

1. walls, bulletin boards, chalkboards, etc...
2. cabinets, cupboards (if fixed and stationary)
3. ceilings
4. floors (when used as a work space)
5. windows (if within arms' reach and visually attending)

Movable Furniture (M)

1. tables, desks, chairs, etc...
2. carts, bookcases, display cases, etc...
3. easels, flannel boards, etc...

Equipment (E)

1. A-V (i.e., projectors, television, recorders, etc...)
2. power tools (i.e., jigsaws, drills, etc...)
3. other (i.e., globes, models, etc...)

Instructional Materials (IM)

1. consumable items with a life span less than a year (i.e., paper, pencil, notebooks, etc...)
2. non-consumable items with a life span more than a year (i.e., books, A-V software, charts, etc...)

Scoring

Add all category interaction scores to get a composite. Divide this total interaction score by the number of minutes subjects were observed. This will result in a rate of student-concrete physical environment interaction, expressed in behaviors per minute.

## Response to Physical Environment Scale

### Administrators Manual

Use

This instrument consists of twenty-three picture triads. It will be used to collect data of a student's responses of preference for classroom physical environments.

Testing Time

Generally testing time does not exceed fifteen minutes.

Size of Group

The scale can be administered individually, in small groups (four or five), or in large groups (six or more). A general "rule of thumb" is that the older the students, the larger the group may be.

General Factors

Format and technique is such that reading is eliminated. In addition the vocabulary was limited so the instrument could be used with a wide range of CA and MA groups.

General Directions (to be read prior to the testing by the test administrator)

This scale is not an achievement or intelligence test. Valid results can only be secured if the students understand the specific directions for each item and feel free to respond truthfully.

The student must understand that there are no right or wrong answers to this scale. Please allow enough time so every student completes the scale.

Specific Directions for Administration

1. Locate an area where testing will not be interrupted.

2. Separate the students somewhat when they are seated, so they cannot see each other's mark on the booklet.
3. Have each student complete the upper half of the face sheet (Walk around and check correctness):
   a. "Write or print your name"
   b. "If you are a boy, put a check after B. If you are a girl, put a check after G."
   c. "The name of our school is _____."
   d. "This is the _____grade."
   e. Examiner--list the name of the person administrating this scale.
   f. Date--list the date this scale was administered.
4. The following directions for the scale may be repeated as many times as necessary.

   "CHOOSE (SELECT) THE PICTURE OF THE CLASSROOM YOU WOULD LIKE TO WORK IN"

   "MARK AN "X" IN THE CIRCLE NEXT TO THE PICTURE YOU PICKED"

   "MARK ONLY ONE PICTURE ON EACH PAGE"

   Check to see whether the students have understood the directions. If not, explain again. If yes, commence with scale. The examiner must not indicate by word or gesture which photograph is preferable.

Directions for Scoring

Count the total number of responses made for pictures A, B, and C. Record the totals for A, B, and C on the booklet face sheet.

If a student has marked more than one item in the triad, consider his response to be the heavier mark, or the mark not showing signs of being erased. If a page

has not been marked or it cannot be scored, please note that on the face sheet.

Use the following scoring key to determine respondents consideration for physical entities of the classroom environment:

Response to Physical Environment

Scoring Key

| Page | Self-Contained Class. (New) | Self-Contained Class. (Old) | Open-Concept Class. (New) | No. of Physical Entities in Classroom |
|---|---|---|---|---|
| 1 | A | B | C | Same |
| 2 | A | B | C | Same |
| 3 | A | B | C | Same |
| 4 | A | B | C | Same |
| 5 | A | B | C | Same |
| 6 | A | B | C | Same |
| 7 | A | B | C | Same |
| 8 | A | B | C | Same |
| 9 | A | B | C | Same |
| 10 | A | B | C | B (Most) |
| 11 | A | B | C | C (Most) |
| 12 | A | B | C | A (Least) |
| 13 | A | B | C | C (Least) |
| 14 | A | B | C | A (Most) |
| 15 | A | B | C | C (Least) |
| 16 | A | B | C | C (Most) |
| 17 | A | B | C | A (Most) |
| 18 | A | B | C | C (Least) |
| 19 | A | B | C | A (Most) |
| 20 | A | B | C | B (Least) |
| 21 | A | B | C | B (Least) |
| 22 | A | B | C | C (Least) |
| 23 | A | B | C | C (Least) |

# Response to Physical Environment Scale

Name _____ ,B _____ G _____

School _____

Class _____

Examiner _____ ,Date _____

by

William Gingold

Oct. 1970

_____ _____ _____ _____

_____ _____ _____ _____

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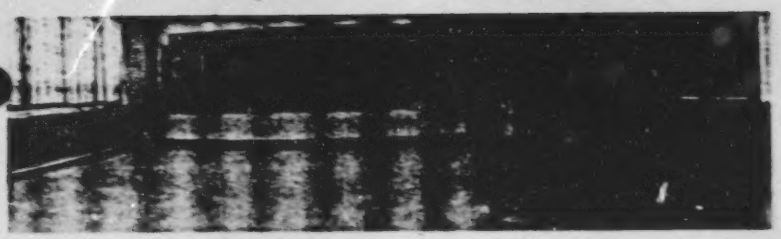

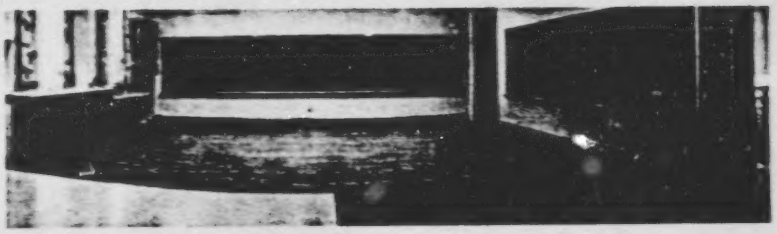

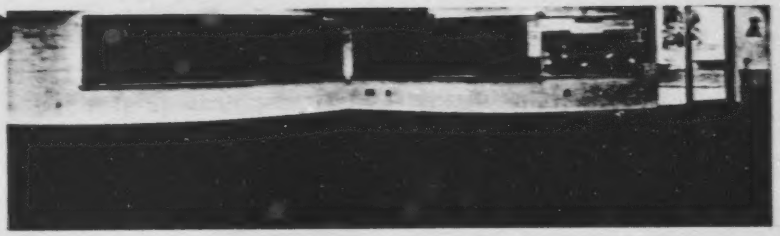

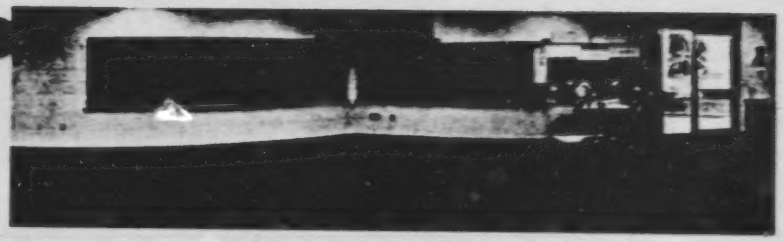

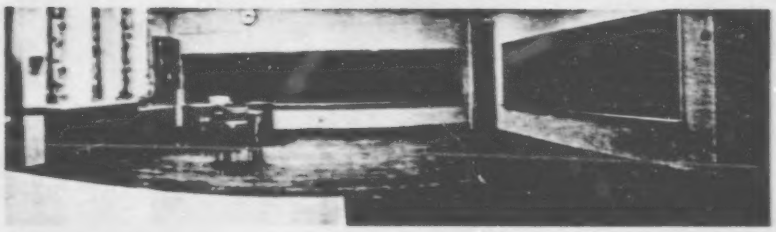

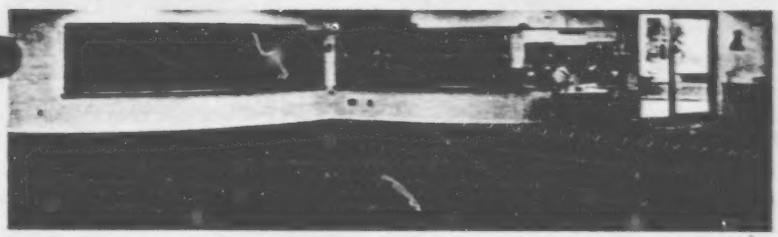

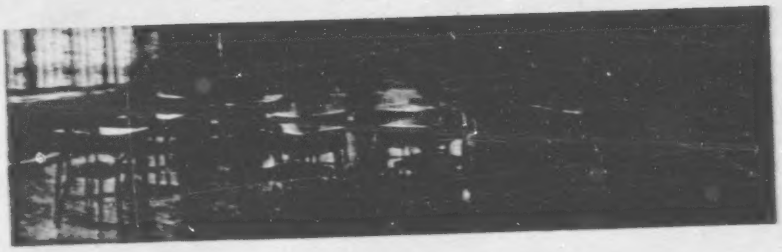

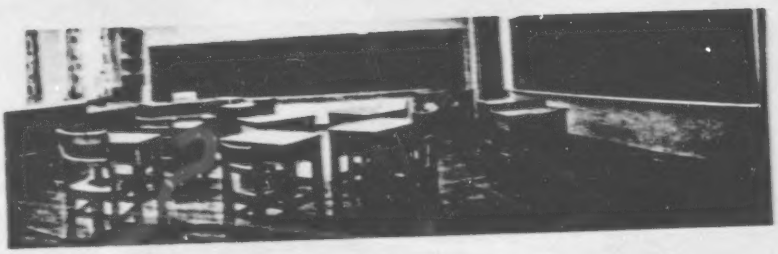

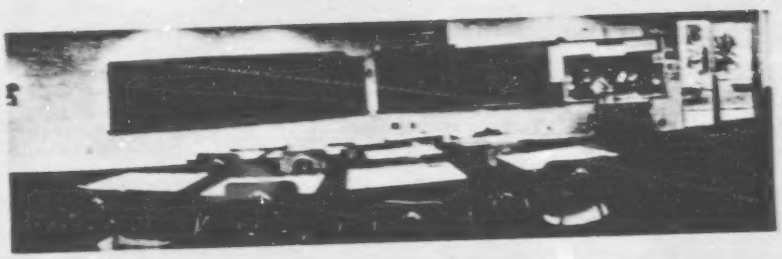

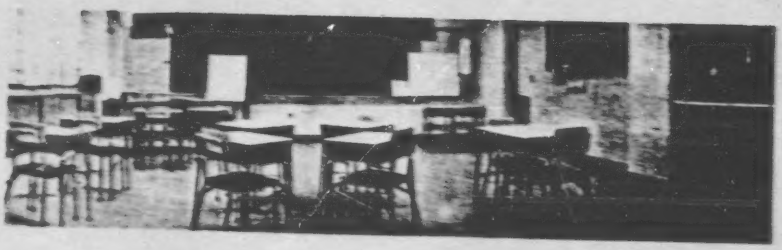

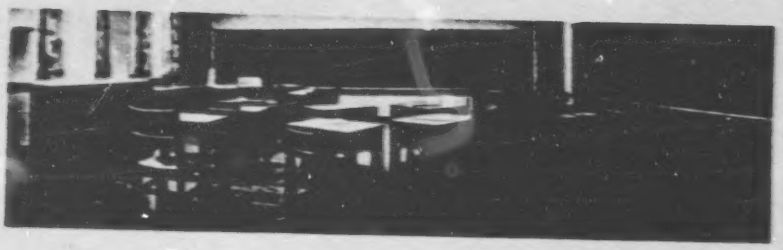

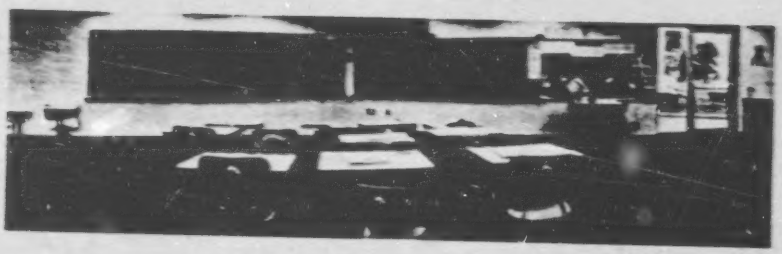

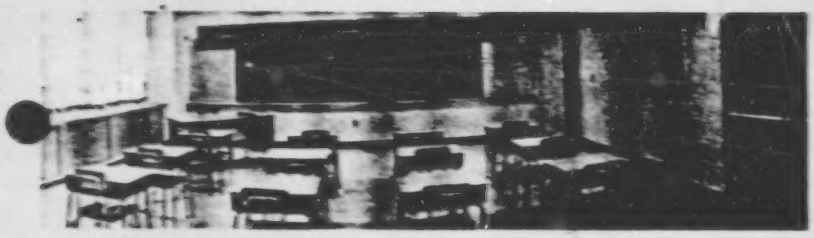

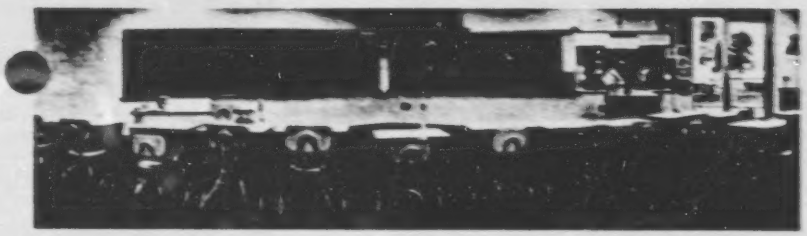



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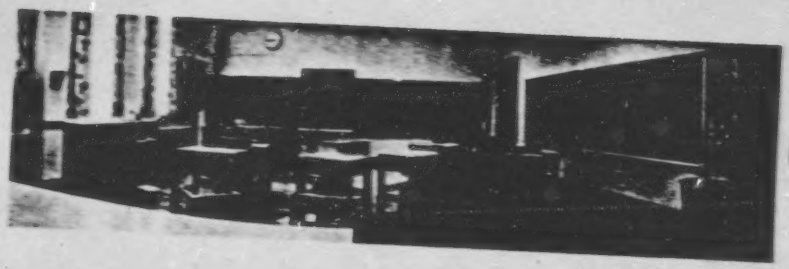

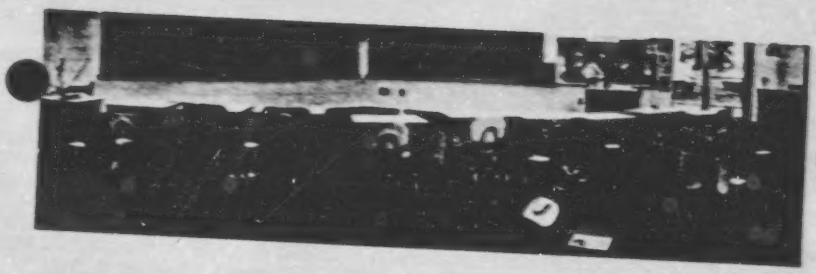

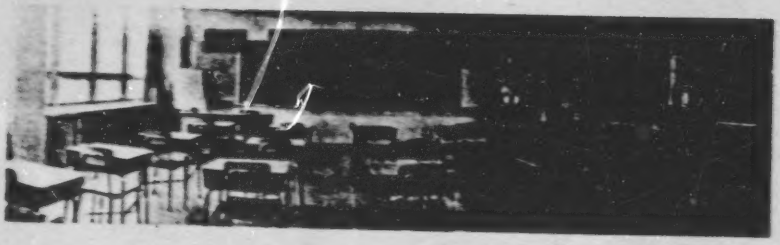

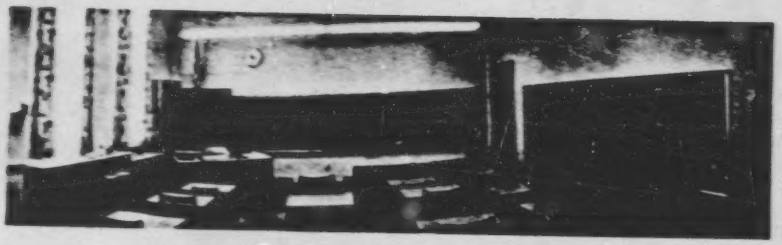

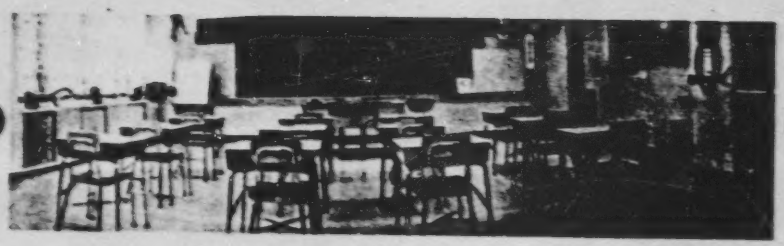

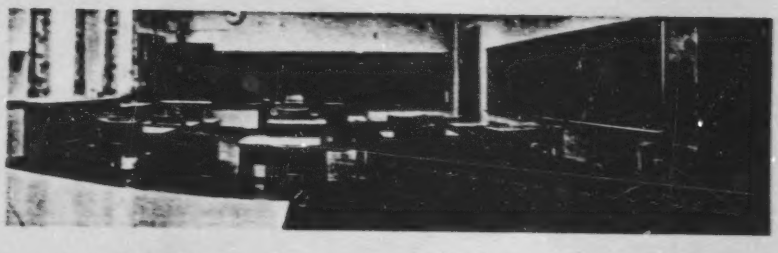

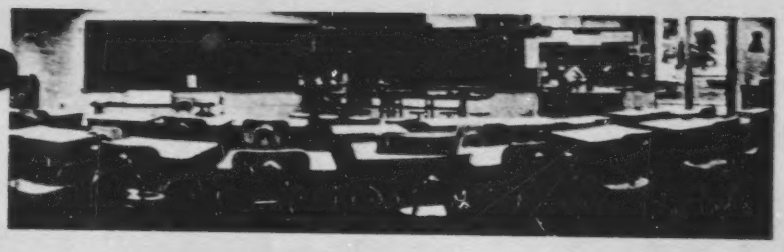



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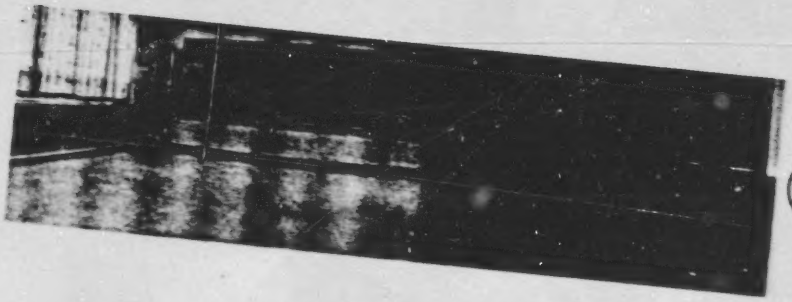

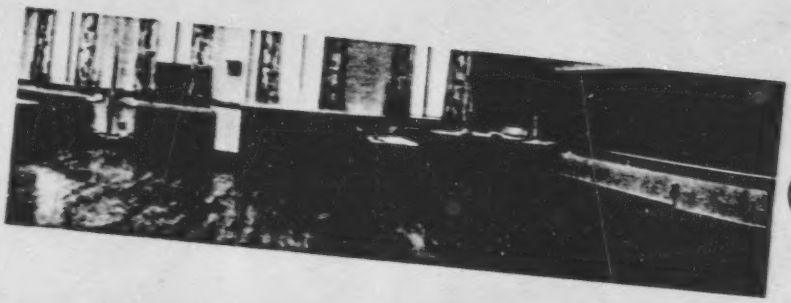

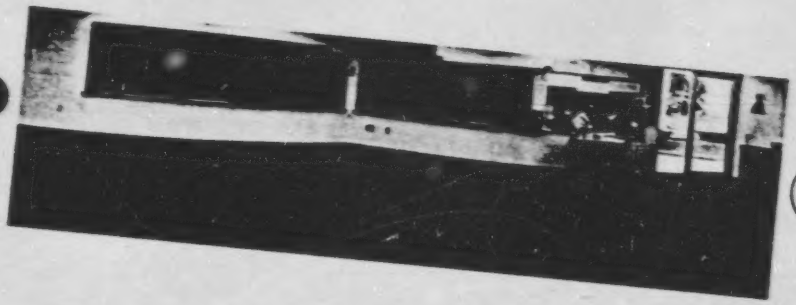

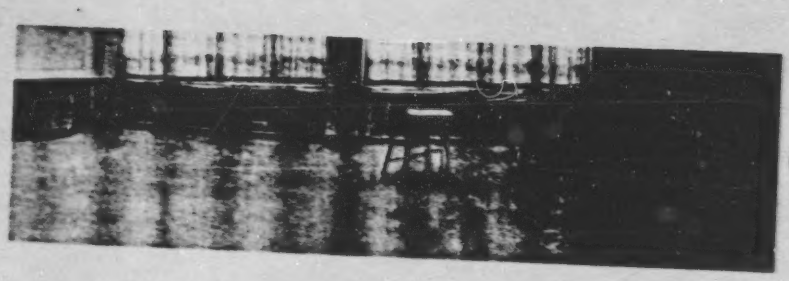

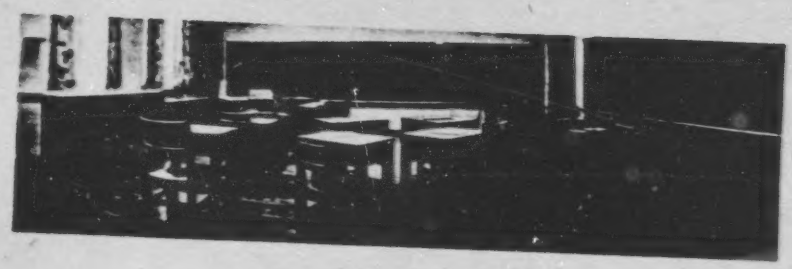

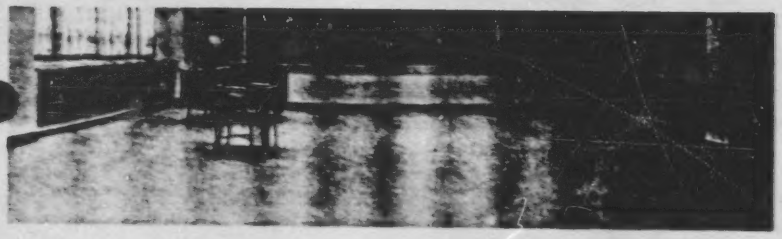

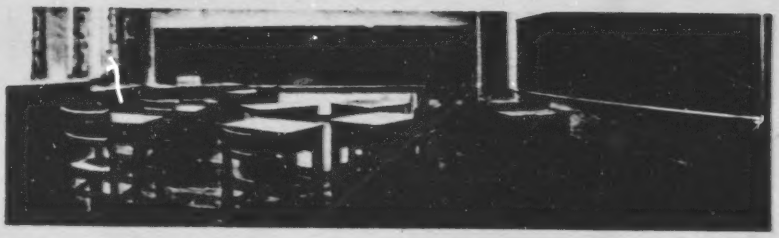

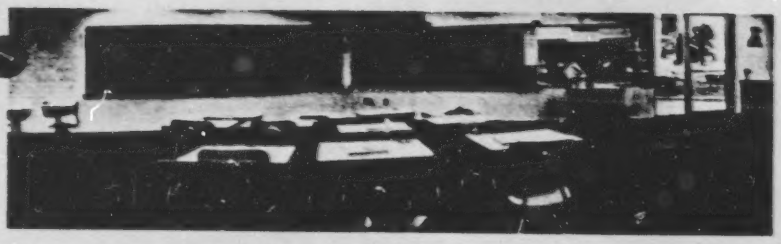

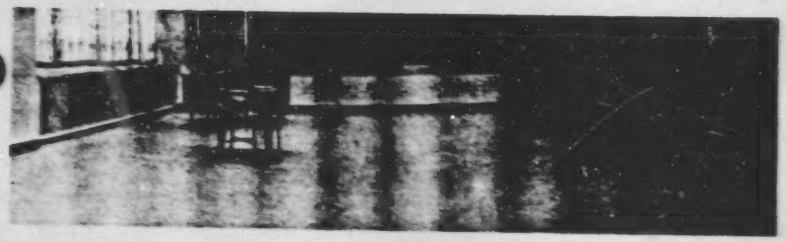

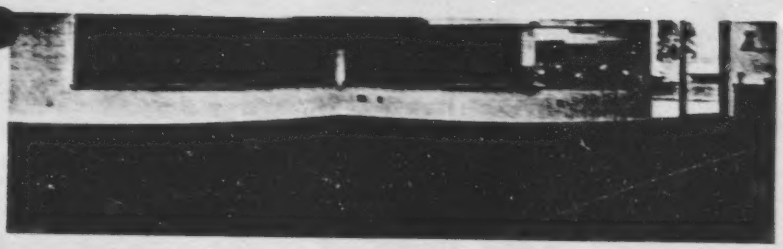



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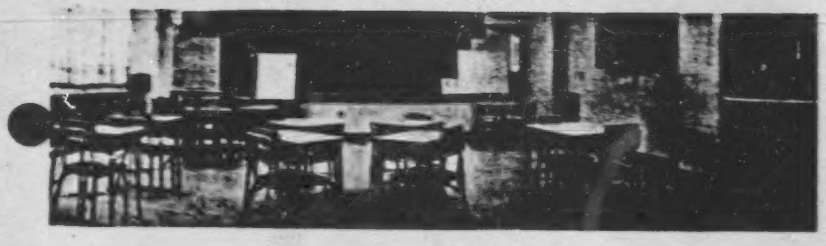

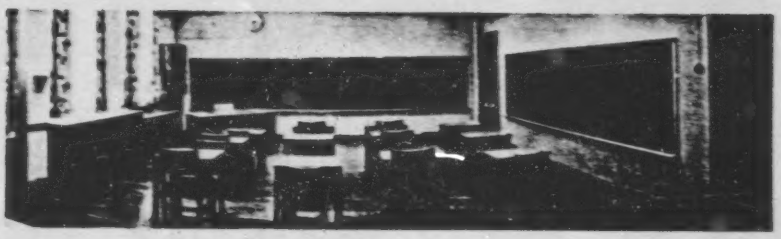

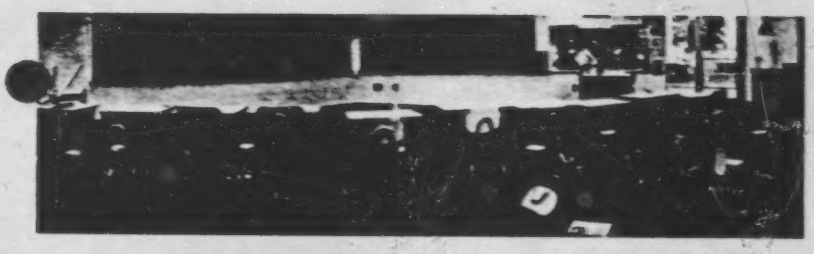

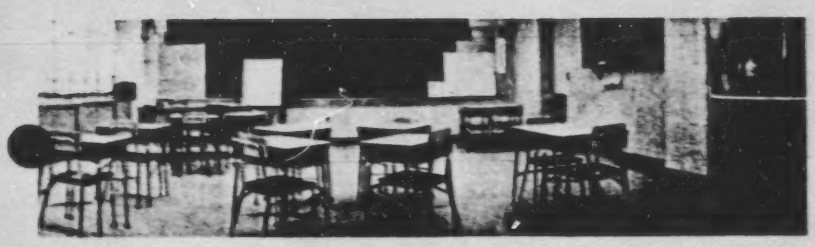

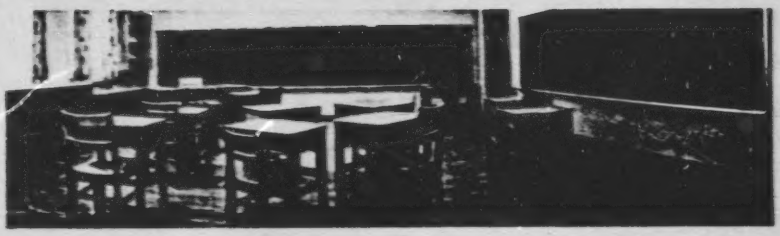

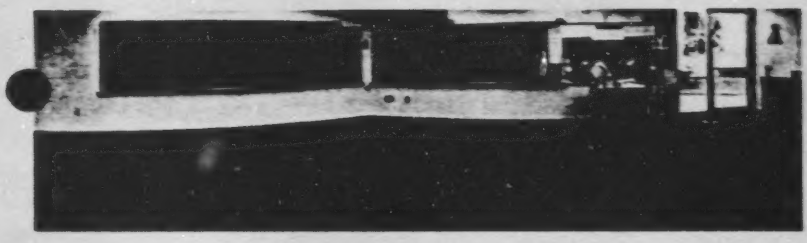

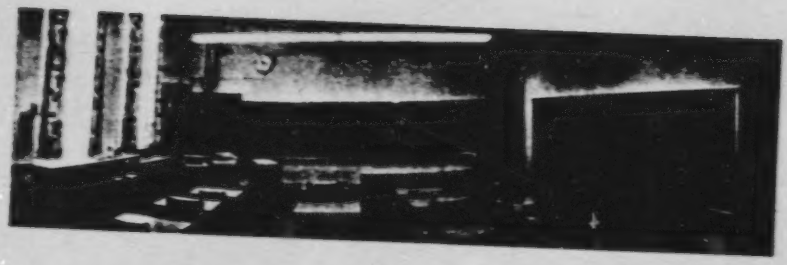

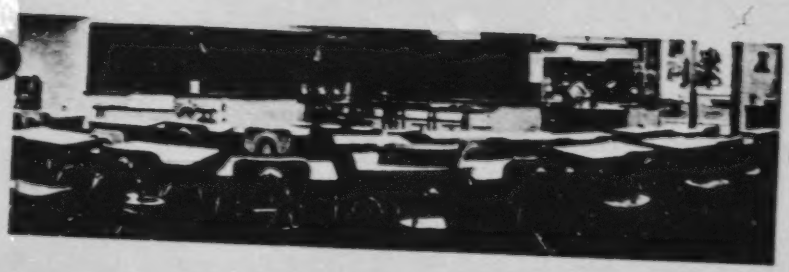



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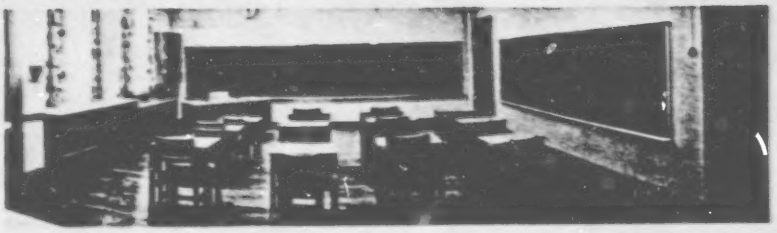

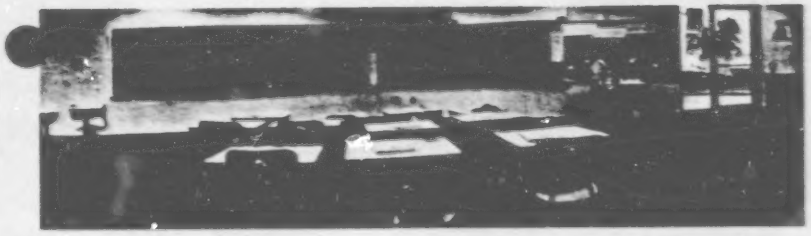

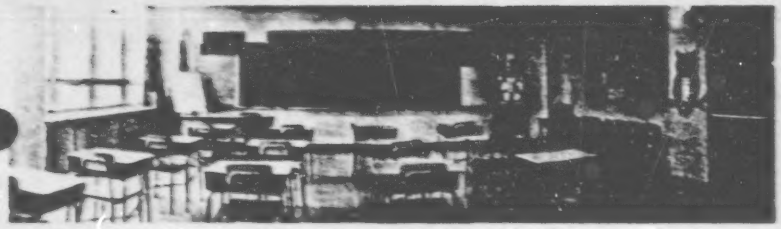

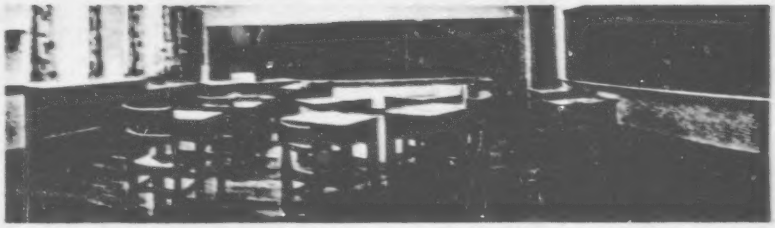

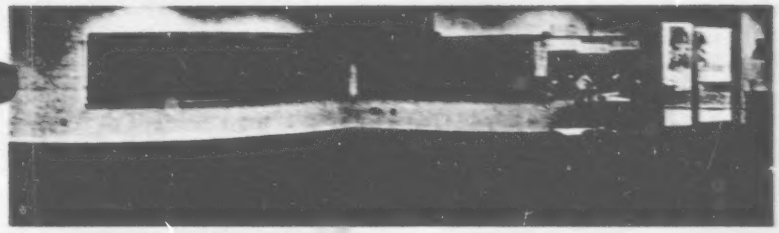

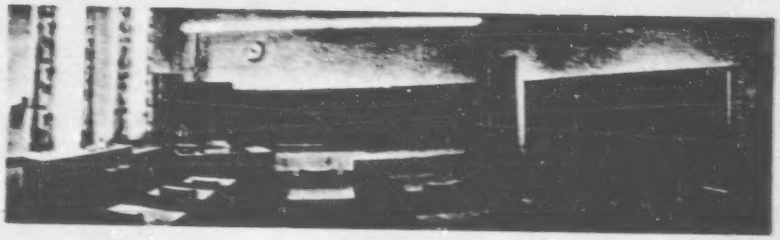

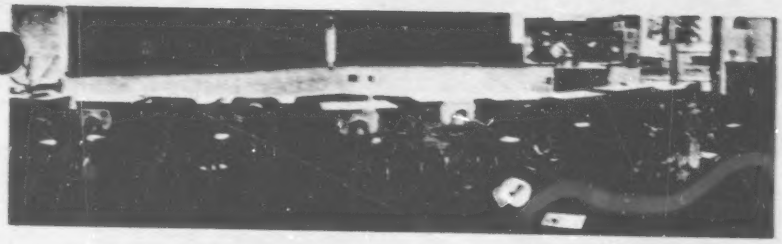



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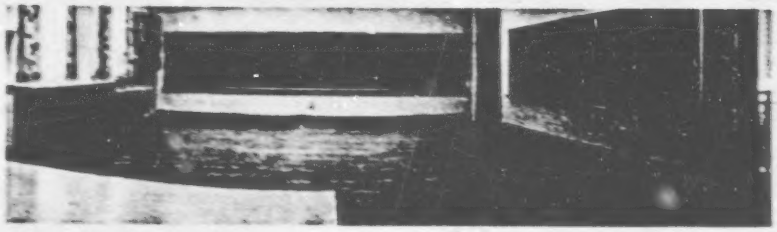

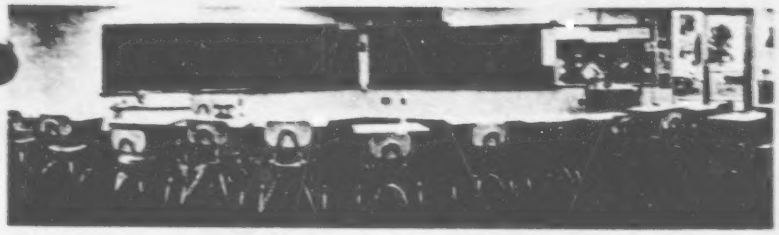

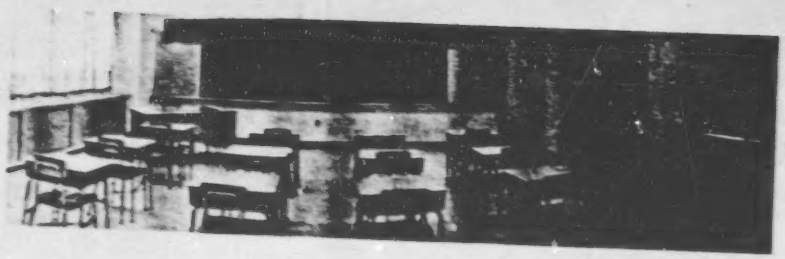

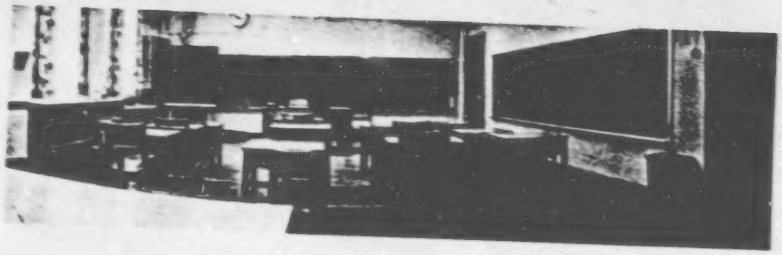

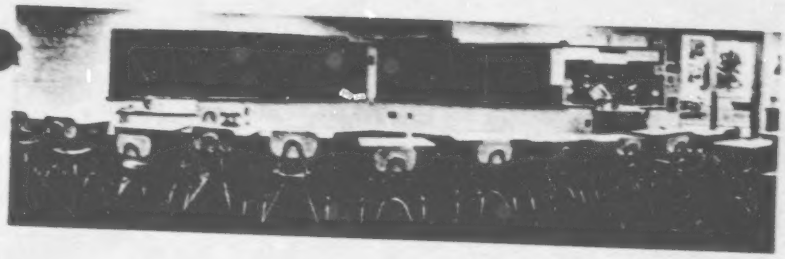



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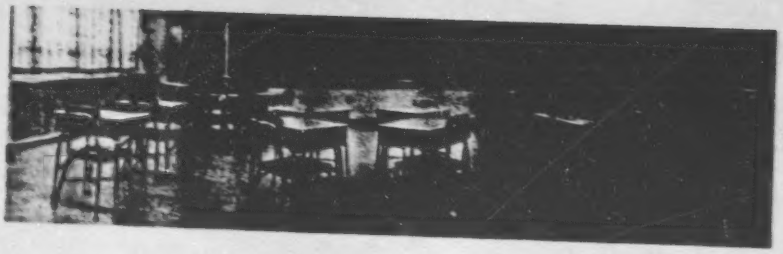
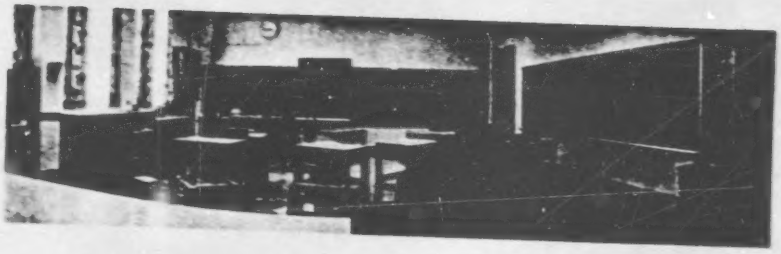
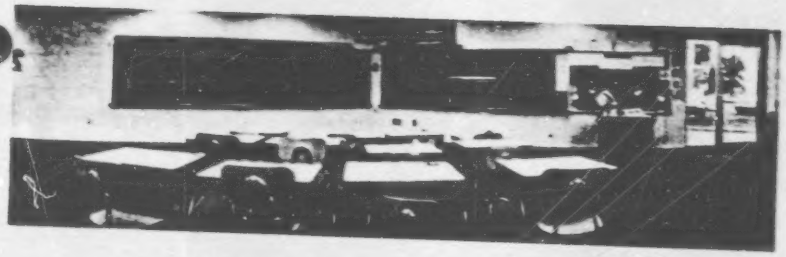






# APPENDIX E

## Picture Match Sequence for RPES

| Page | Picture Numbers for Categories | | |
|---|---|---|---|
| | A* | B* | C* |
| 1 | 1 | 1 | 1 |
| 2 | 2 | 2 | 2 |
| 3 | 3 | 3 | 3 |
| 4 | 4 | 4 | 4 |
| 5 | 5 | 5 | 5 |
| 6 | 6 | 6 | 6 |
| 7 | 7 | 7 | 7 |
| 8 | 8 | 8 | 8 |
| 9 | 9 | 9 | 9 |
| 10 | 1 | 2 | 3 |
| 11 | 2 | 5 | 8 |
| 12 | 3 | 4 | 5 |
| 13 | 3 | 2 | 1 |
| 14 | 5 | 6 | 7 |
| 15 | 5 | 4 | 3 |
| 16 | 7 | 8 | 9 |
| 17 | 7 | 6 | 5 |
| 18 | 8 | 5 | 2 |
| 19 | 9 | 3 | 7 |
| 20 | 6 | 1 | 4 |
| 21 | 4 | 1 | 6 |
| 22 | 6 | 9 | 6 |
| 23 | 4 | 7 | 4 |

* A = "Old" self-contained

B = "New" self-contained

C = "New" open-concept

# Reliability* Data - Response to Physical Environment Scale (Test-Retest with One Week Interval)

| School | Grade | N |
|---|---|---|
| Nashotah | 8 | 15 |
| South Park Elem. | 4 | 28 |
| Nashotah | 3 | 23 |
| Total | | 66 |

$$2 = \frac{|1\ P - 0.33| \ - \ 1/(2N)}{\sqrt{\frac{(0.33)\ (0.33)}{N}}}$$

*Reliability defined, in this context, as the generalizability over all possible occasions for a mixed number of items.

APPENDIX G

DRAW-A-CLASSROOM TEST
(DACT)

USE

This instrument will be used to collect data of students' attending behavior to concrete physical entities in the classroom environment. This test has no time limit or right and wrong answers. It may be administered individually or in groups.

DIRECTIONS

This instrument is to be administered to the subjects when they are in a room other than their own homeroom. Please separate the students so it becomes difficult for them to see each others' drawings.

The specific directions to the students are as follows: "HERE IS A SHEET OF PAPER (blank 8 1/2" x 11" white paper) AND A PENCIL (students can use their own). DRAW A PICTURE OF MR.(S)._____ CLASSROOM. BEFORE YOU START, PUT YOUR NAME IN THE RIGHT HAND CORNER OF THE PAPER."

Allow students ample time to complete task. Questions may be answered but no clue should be given as to what they should include in their picture.

SCORING (Not to be discussed with DACT respondents)

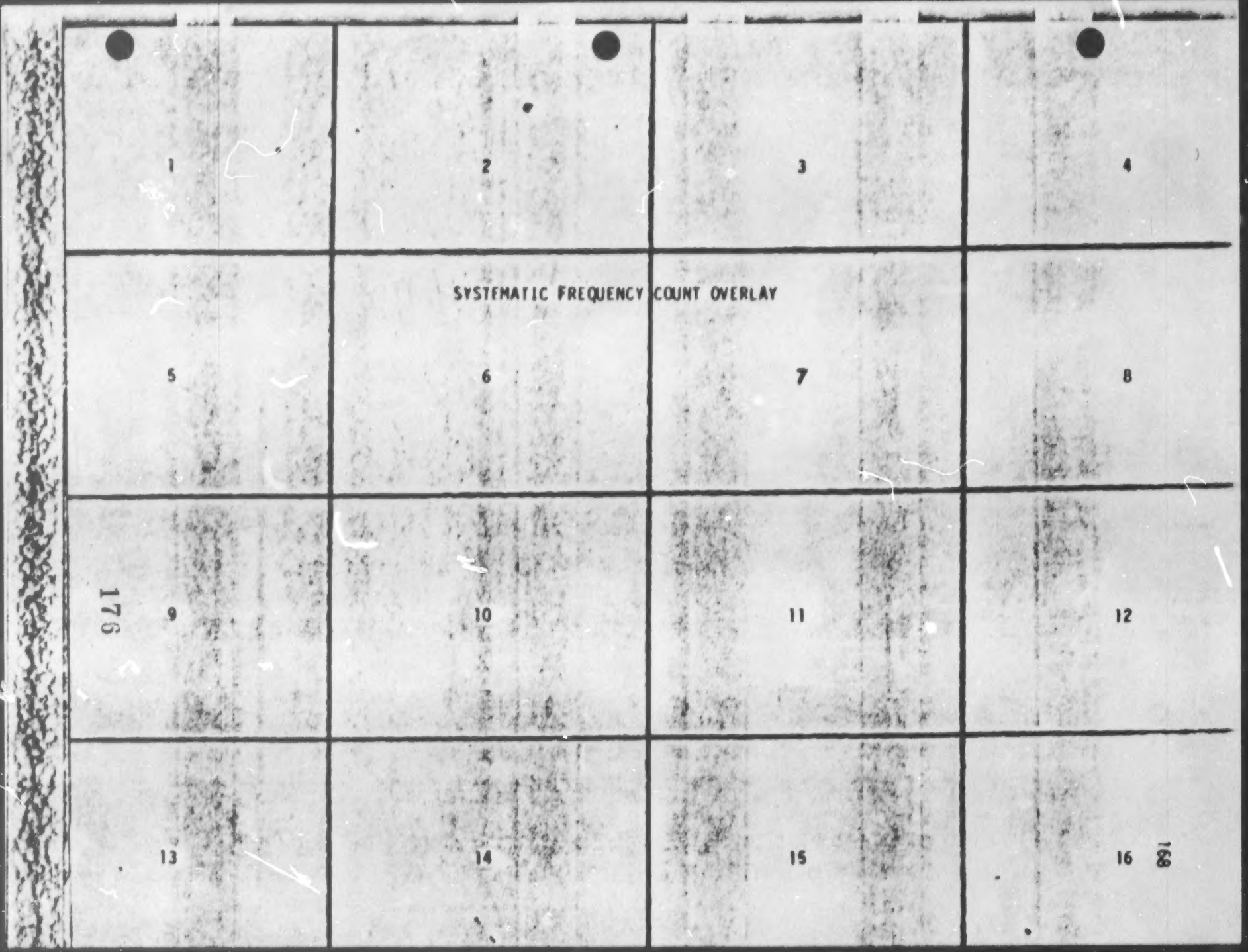
Scoring will be based on a frequency tabulation of concrete physical features included in the drawing. Esthetic quality will not be considered in the analysis of the drawings.

Utilize the attached Systematic Frequency Count Overlay to aid you in achieving an accurate frequency count for each drawing. Simply take the SFCO transparency

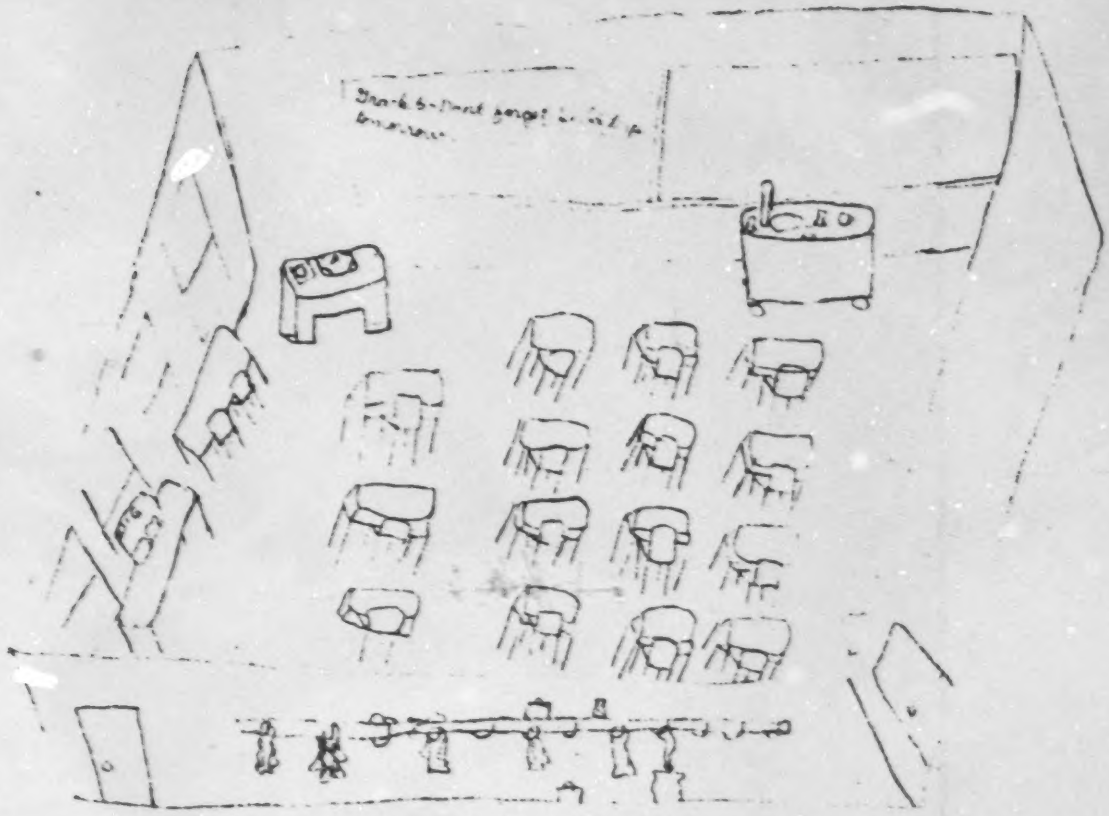
and place it over the subject's drawing. Please note that the grid rectangles are numbered in sequence. Proceeding in sequence count all or part of the objects that fall within a grid rectangles. If the object has been counted in a preceding grid rectangle, don't count it again. By utilizing the SFCO, you will have a systematic approach by which an accurate frequency count will be derived.

To guard against confabulation, frequently check the subjects drawings with the actual photographs of the room.*

*Polaroid photographs of the room should be taken during the week in which the DACT is administered.


1
2
3
4
SYSTEMATIC FREQUENCY COUNT OVERLAY
5
6
7
8
9
10
11
12
13
14
15
16

SAMPLE: DRAW-A-CLASSROOM



# APPENDIX H

## Behavior Quadrant Analysis

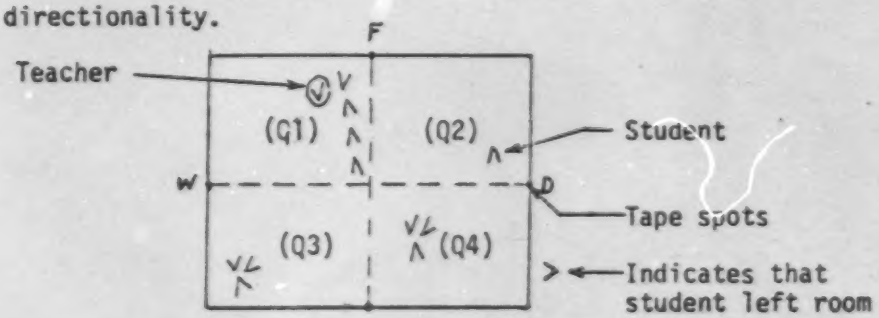
Use

The Behavior Quadrant Analysis is to be utilized to determine movement behavior within a teacher defined physical space. This physical space may be a cell shaped classroom or a defined open space. A defined open space is usually recognized by the outline of furnishings which indicates territoriality.

General Directions (Instrument Construction)

The initial step for this instrument is to scale the classroom or defined open space. Use such a scale which will allow you to duplicate the same space nine times on 8-1/2" x 11 sheet of paper. Once this has been accomplished, divide the space in four approximately equal sections, which are to be referred to as "behavior quadrants." These quadrants should be discretely marked by "tape spots" in the actual classroom. This will assist the observer to identify in which quadrant students are located at given point in time.

In addition indicate directional reference to the given space by marking an F for front, a W for windows and D for doors. In the figure below note the symbols that will be used to denote teacher, student, and directionality.



Specific Directions (Utilizing Scale)

Observer should locate himself at the front of the room, whereby all subjects within the given space are visible to him. At five minute intervals, mark the location of the students and teacher within the defined space on the scaled drawings. The apex of the mark should indicate the facial direction of the subjects.

Scoring

Based on the recorded notations of student location within each quadrant from time interval to time interval, tally the behavior movement changes that occurred from quadrant to quadrant for the whole observation period. Based on this tally, determine the rate of movement behavior for observational period. Rate can be computed as follows:

$$\text{Rate} = \frac{\text{frequency (movement behavior)}}{\text{time (observation period)}}$$

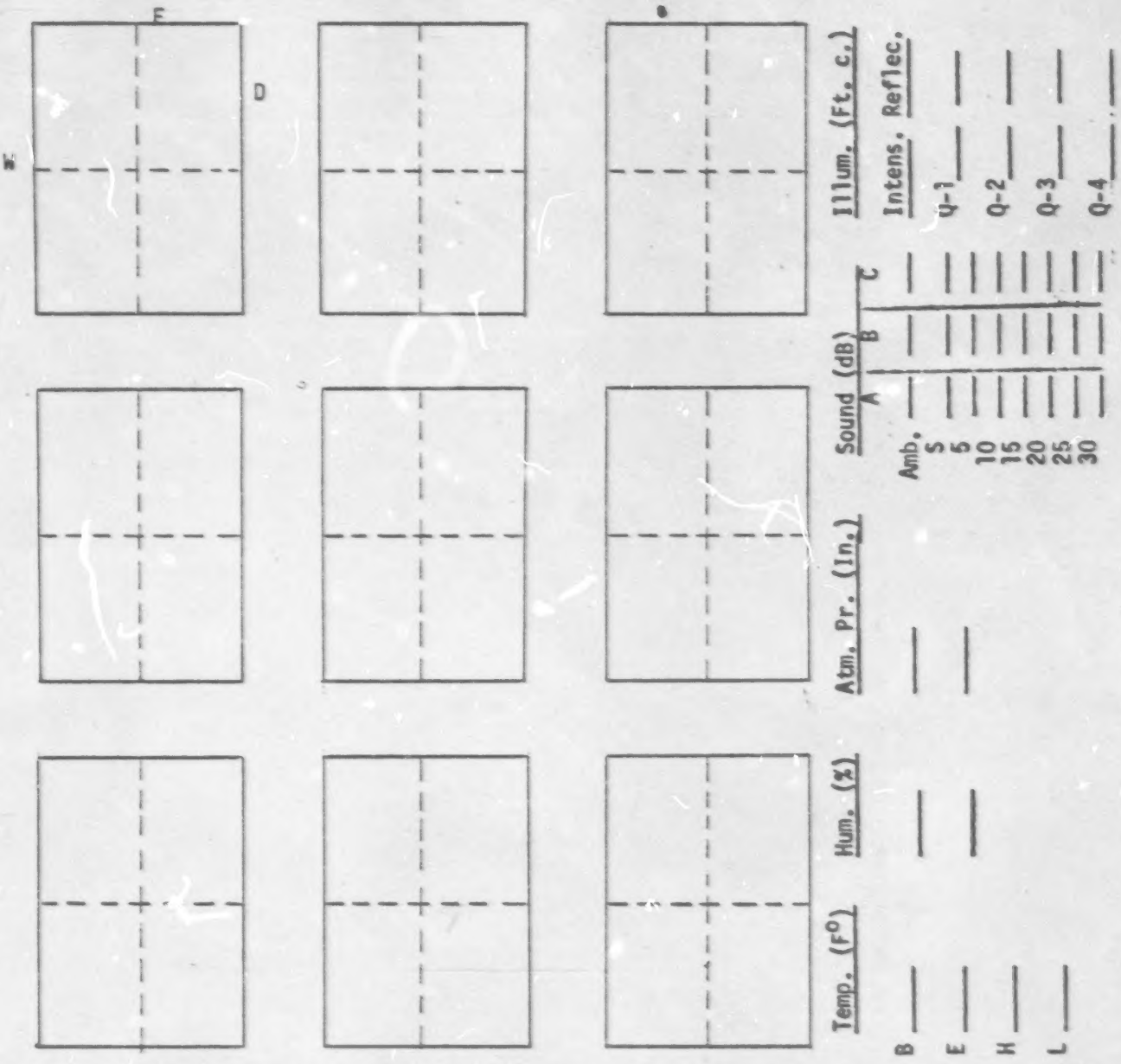
SAMPLE: BEHAVIOR QUADRANT ANALYSIS SHEET

School I
Class or Grade 5
Subject SOC. STUD.
Date
Time
N

Observational Period
Data Sheet
(Scale 1/16" = 1' - 0")

^ = Pupil
Ⓐ = Teacher
F = Front of room
W = Window
D = Door

172




R - CP - EI Frequency:

HC (_____) + I (_____) + M (_____) + E (_____) + M (_____) = TI (_____)

Attending Behavior (Min.):

TB (_____) - DB (_____) = AB (_____)

# APPENDIX J

## Impact of Facilities Scale

## (IFS)

Use:

This instrument is to be used to obtain the changes of staff reactions when a change in school facility occurs. Consequently it will measure the changes in teacher perception regarding the affects the "new" facility will have on student and teacher (self) behavior.

Testing Time:

Actual testing time will vary between ten to twenty minutes.

Size of Group:

Instrument may be administered on a group or individual basis. Administration time is approximately the same in both situations.

General Factors:

This instrument consists of two forms. Form A-1 is to be administered to staff while located in "old" facility. Form A-2 is to be administered to the same staff after they have been in the "new" facility for a minimum of four weeks.

General Directions (to be read by test administrator prior to testing):

1. Each subject needs to complete both forms before any statistical analysis can be made.
2. If subject is to respond to instrument in leisure, stress to them that they read the instructions carefully.
3. Use the Specific Directions when administering this instrument to a group.

Specific Directions:

Say the following:

"WHILE YOU READ THE DIRECTIONS ON TOP OF THIS SILENTLY, I WILL READ THEM ALOUD TO YOU."

Read this for Form A-1:

"MARK A VERTICAL LINE ("I") AT A POINT ON THE HORIZONTAL LINE WHICH YOU FEEL BEST DESCRIBES THE SITUATION, CONDITION OR BEHAVIOR THAT YOU FEEL WILL EXIST IN THE NEW SCHOOL OR CLASSROOM FACILITY. WORK AS QUICKLY AS YOU CAN WITHOUT SPENDING TOO MUCH TIME ON ANY ONE ITEM."

Read this for Form A-2:

"MARK A VERTICAL LINE ("I") AT A POINT ON THE HORIZONTAL LINE WHICH YOU FEEL BEST DESCRIBES THE SITUATION, CONDITION OR BEHAVIOR THAT YOU

FEEL EXISTED IN THE NEW SCHOOL OR CLASSROOM FACILITY. WORK AS QUICKLY AS YOU CAN WITHOUT SPENDING TOO MUCH TIME ON ANY ONE ITEM."

Finally say this:

"NOW LOOK AT THE EXAMPLE. ARE THERE ANY QUESTIONS AS TO WHAT NEEDS TO BE DONE? PLEASE START."

Scoring (Not to be discussed with respondents):

To score each completed IFS instrument use the IFS scoring overlays for the appropriate forms. Place the overlay over the appropriate instrument and note the location of the vertical line in relation to the graduated horizontal scale. Next to each horizontal line indicate the numerical value for the vertical line location. These values are the scores the respondents receive for all the given items. This scoring procedure is to be accomplished for both Forms of the scale. When this is done, appropriate statistical techniques can be utilized either on a composite basis which requires noting reversal values for items 19, 20, 33, 38, 39, 40, 42, 43, 46 and 52, or making an item analysis for a given factor or factor analyzing to determine clustering of factors.



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Form A-1

# Impact of Facilities Scale
# (IFS)
by
William Gingold

Dear Staff:

This instrument is a means through which we can get your reactions as to how the new school facility will affect your students and possibly your own feelings.

Directions: Mark a vertical line ("|") at a point on the horizontal line which you feel best describes the situation, condition or behavior that you feel will exist in the new school or classroom facility. Work as quickly as you can without spending too much time on any one item.

Here is an example:
Today the temperature outside will be: HOT _____|_____ COLD

Do the following items as quickly as possible.

| | | | |
|---|---|---|---|
| 1. | The new classroom(s) will be:..... | BENEFICIAL | _____ HARMFUL |
| 2. | Student health will be:..... | GOOD | _____ BAD |
| 3. | The classroom will be:..... | SAFE | _____ DANGEROUS |
| 4. | Children will be:..... | HAPPY | _____ SAD |
| 5. | Student behavior will be:..... | SOCIABLE | _____ UNSOCIABLE |
| 6. | Teachers will be:..... | GRATEFUL | _____ UNGRATEFUL |
| 7. | Students will be:..... | GRATEFUL | _____ UNGRATEFUL |
| 8. | Student attitudes will be:..... | HARMONIOUS | _____ DISSONANT |
| 9. | Classroom(s) will be:..... | LIGHT | _____ DARK |
| 10. | Student movements will be:..... | GRACEFUL | _____ AWKWARD |
| 11. | Student physical movements will:..... | INCREASE | _____ DECREASE |
| 12. | Classroom(s) will be:..... | COMFORTABLE | _____ UNCOMFORTABLE |
| 13. | Students will be:..... | HEALTHY | _____ SICK |
| 14. | Students' physical activity will be:..... | VIGOROUS | _____ FEEBLE |
| 15. | Student interactions will be:..... | FREE | _____ CONSTRAINED |
| 16. | Classroom atmosphere will be:..... | HUMOROUS | _____ SERIOUS |
| 17. | Students' behavior will be:..... | ACTIVE | _____ PASSIVE |
| 18. | Teacher reaction to student behaviors will be:..... | CALM | _____ EXCITABLE |
| 19. | Changes in classroom temperatures will be:..... | SIGNIFICANT | _____ INSIGNIFICANT |
| 20. | Classroom humidity will be:..... | HIGH | _____ LOW |
| 21. | Student mobility in the classroom will be:..... | FAST | _____ SLOW |
| 22. | Student moods will be:..... | STABLE | _____ ERRATIC |

184 BEST COPY AVAILABLE

| | | | |
|---|---|---|---|
| 23. | Teacher response to discipline problems will be: | CAUTIOUS | RASH |
| 24. | Use of instructional media will be: | FREQUENT | SELDOM |
| 25. | Classroom activities will be: | USUAL | UNUSUAL |
| 26. | At the end of school day, students will be: | REFRESHED | WEARY |
| 27. | At the end of school day, staff will be: | REFRESHED | WEARY |
| 28. | Student behavior will be: | ATTENTIVE | INATTENTIVE |
| 29. | Student behavior will be: | AGGRESSIVE | DEFENSIVE |
| 30. | Students' positive attitudes toward school will be: | REVEALED | CONCEALED |
| 31. | Student interaction will be: | COMPETITIVE | COOPERATIVE |
| 32. | Student "on-task" behaviors will be: | PERIODIC | ERRATIC |
| 33. | Students' disruptive behavior will: | INCREASE | DECREASE |
| 34. | Students' "attending" behavior will: | INCREASE | DECREASE |
| 35. | Students' academic achievement will: | INCREASE | DECREASE |
| 36. | Individual reactions to building will be: | FAVORABLE | UNFAVORABLE |
| 37. | Instructional materials usage will: | INCREASE | DECREASE |
| 38. | Student "out-of-seat" behavior will: | INCREASE | DECREASE |
| 39. | Time required to complete assigned tasks will: | INCREASE | DECREASE |
| 40. | Classroom noise will: | INCREASE | DECREASE |
| 41. | "Good" behavior will: | INCREASE | DECREASE |
| 42. | Disruptive behavior will: | INCREASE | DECREASE |
| 43 | Teachers' planning time will: | INCREASE | DECREASE |
| 44. | Physical contact between students will: | INCREASE | DECREASE |
| 45. | Within classroom physical movement will: | INCREASE | DECREASE |
| 46. | Classroom illumination will be: | DARK | LIGHT |
| 47. | Student attendance will: | INCREASE | DECREASE |
| 48. | Group interaction will: | INCREASE | DECREASE |
| 49. | Children's behavior will be: | OVERT | COVERT |
| 50. | Student-teacher relationship will be: | SENSITIVE | INSENSITIVE |
| 51. | Students' completing assigned tasks will: | INCREASE | DECREASE |
| 52. | Classroom temperature changes will be: | SIGNIFICANT | INSIGNIFICANT |

Optional:

Name: _____ Grade: _____

School: _____ Date: _____



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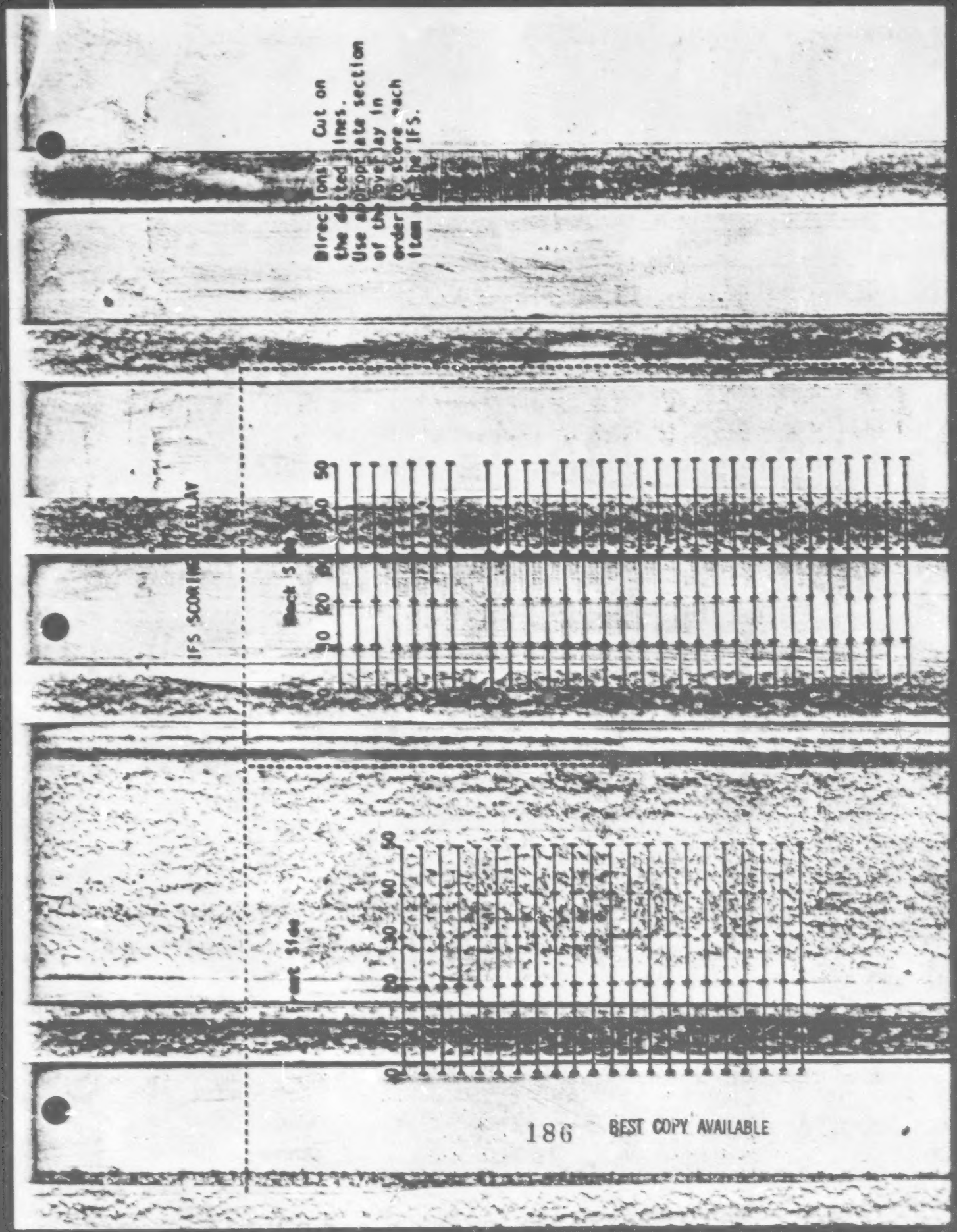
Directions: Cut on the dotted lines. Use appropriate section of the overlay in order to score each item on the IFS.
IFS SCORING OVERLAY
Back S
0 10 20 30 40 50
Part Sim
0 10 20 30 40 50


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# APPENDIX K

## Your Feelings

### Use

This instrument consists of ten statements pertaining to the student's own personal feelings in relation to the physical environment.

### Testing Time

Generally testing time does not exceed ten minutes.

### Size of Group

Instrument can be administered individually, in small groups or in large groups.

### Directions (Pre-read before administration)

1. Pass out to each student a YF Response Sheet.
2. Have each student complete the necessary information on the upper right corner of the sheet.
3. Explain to the students that the column "old" represents the school building that they came from and that the "new" represents their present building. "Same" is to be marked when they cannot decide between the "old" and the "new."
4. Read each statement to your students. Have them respond by making an "X" in the appropriate column for each item. Please be sure to check that only one mark ("X") is made for an item.

5. You may repeat the statements as often as necessary. Words may be explained if necessary. No clues should be given to the students indicating your personal preference.
6. Emphasize the fact that there is no one right or wrong answer. The students should respond to the way they feel about each statement.

Statements

Read Each Statement Verbatim.

1. It is the building that I like the best.
2. It is the building where I do my best work.
3. It is the building where I can spend more time with my friends.
4. It is the building where my teacher seems happiest.
5. It is the building where I am able to learn better.
6. It is the building where I am able to behave the best.
7. It is the building where I am able to move around the most.
8. It is the building where my work seems easiest.
9. It is the building where I am able to pay attention best.
10. If I were able to build a school building, it would be most like _____.

YF Response Sheet

NAME: _____

SCHOOL: _____

GRADE: _____

DATE: _____

| | OLD | NEW | SAME |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |

# APPENDIX L

Sample: Descriptive Physical Data of Classroom Spaces

District: I School: "New" Grade: 2

Facilities Age: New - moved into structure Feb. 22, 1971

Classroom Space Location: All on one level - "open concept" - total instructional area 148'-0" X 200'-0"

Room Dimension (May be student defined space): Student defined. Area somewhat oval in shape - 40'-0" X 43'-9"

Ceiling: 9'-0" - off-white suspended acoustical tile

Walls: Textured vinyl fabric - bayish brown

Light: 24-4'-0" fluorescent lights

Heat: Hot water with forced air - Trane Climate Changer Type 63

Windows (N, Dimen., L.C.): None within student defined space

Boards (CB and BB): 2 black CB and 1 green flannel covered BB

Floor: Green carpet throughout total instructional area

Other Salient Features: No individual student stations. Trapezoid-shaped tables and multi-colored chairs used. Cabinets and bookcases generally define instructional area.

Student (Random) Responses: "I like the rug--can lay on it."

"People too close, they blab all the time."

"I like the desk in the old."

"It's cleaner here."

"Water fountain nice."

APPENDIX M

Number of respondents to instruments

| School | Grade or Staff | IFS Pre | IFS Post | DAC | YF | RPES |
|---|---|---|---|---|---|---|
| I | 2 | -- | -- | 24 | 24 | 24 |
| I | 4 | -- | -- | 26 | 25 | 26 |
| I | 5 | -- | -- | 26 | 26 | 26 |
| I | 6 | -- | -- | 26 | 31 | 28 |
| I | Teachers | 13 | 11 | -- | -- | -- |
| II | 4 | -- | -- | 9 | 11 | 12 |
| II | 5 | -- | -- | 24 | 25 | 28 |
| II | 6 | -- | -- | 21 | 24 | 22 |
| II | 7 | -- | -- | 13 | 15 | 15 |
| II | Teachers | 5 | 5 | -- | -- | -- |
| III | Primary | -- | -- | 14 | 15 | 14 |
| III | Intermediate | -- | -- | 13 | 13 | 13 |
| III | Jr. H. S. | -- | -- | 11 | 12 | 12 |
| III | Teachers | 7 | 10 | -- | -- | -- |
| Total | | 25 | 26 | 207 | 221 | 220 |

# APPENDIX N
## CONTINGENCY TABLES

School I

| | "Old" | "New" |
|---|---|---|
| A | 326 | 301 |
| B | 157 | 111 |
| C | 468 | 539 |

| "Old" | "New" |
|---|---|
| 313.5 | 313.5 |
| 134.0 | 134.0 |
| 503.5 | 503.5 |

School II

| "Old" | "New" |
|---|---|
| 194 | 176 |
| 110 | 82 |
| 334 | 390 |

| "Old" | "New" |
|---|---|
| 185.5 | 185.5 |
| 96.0 | 96.0 |
| 366.5 | 366.5 |

School III

| "Old" | "New" |
|---|---|
| 144 | 122 |
| 75 | 80 |
| 133 | 150 |

| "Old" | "New" |
|---|---|
| 133.2 | 133.2 |
| 77.6 | 77.6 |
| 141.7 | 141.7 |

APPENDIX P

CORRELATION ANALYSIS

TABLE OF CORRELATIONS AND COUNTS

| | HC | TISTB | TEMPM | TEMPD | APM | APD | DBAM | DBBM | DBCM | ILLM |
|---|---|---|---|---|---|---|---|---|---|---|
| HC | 1.000 ( 186) | | | | | | | | | |
| TISTB | -.155 ( 186) | 1.000 ( 186) | | | | | | | | |
| TEMPM | -.216 ( 186) | .249 ( 186) | 1.000 ( 187) | | | | | | | |
| TEMPD | .124 ( 186) | -.238 ( 186) | -.031 ( 187) | 1.000 ( 187) | | | | | | |
| APM | .193 ( 186) | -.211 ( 186) | -.223 ( 187) | .051 ( 187) | 1.000 ( 187) | | | | | |
| APD | .102 ( 186) | -.062 ( 186) | .110 ( 187) | .082 ( 187) | -.183 ( 187) | 1.000 ( 187) | | | | |
| DBAM | .038 ( 186) | -.081 ( 186) | .206 ( 187) | .068 ( 187) | -.073 ( 187) | -.101 ( 187) | 1.000 ( 187) | | | |
| DBBM | .057 ( 186) | -.169 ( 186) | .010 ( 187) | .009 ( 187) | -.015 ( 187) | -.097 ( 187) | .707 ( 187) | 1.000 ( 187) | | |
| DBCM | .034 ( 186) | -.117 ( 186) | -.014 ( 187) | -.052 ( 187) | -.183 ( 187) | -.061 ( 187) | .382 ( 187) | .437 ( 187) | 1.000 ( 187) | |
| ILLM | .089 ( 186) | -.269 ( 186) | -.180 ( 187) | .056 ( 187) | .396 ( 187) | -.028 ( 187) | -.134 ( 187) | -.025 ( 187) | .108 ( 187) | 1.000 ( 187) |
| REFM | -.009 ( 186) | -.216 ( 186) | -.117 ( 187) | .075 ( 187) | .376 ( 187) | -.063 ( 187) | -.132 ( 187) | -.083 ( 187) | -.014 ( 187) | .870 ( 187) |
| IM/RM | .169 ( 186) | .047 ( 186) | -.102 ( 187) | -.038 ( 187) | -.183 ( 187) | .107 ( 187) | .056 ( 187) | .125 ( 187) | .123 ( 187) | - 243 ( 187) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RHM | -.194 ( 186) | .151 ( 186) | .112 ( 187) | -.053 ( 187) | -.528 ( 187) | -.004 ( 187) | .122 ( 187) | .021 ( 187) | -.055 ( 187) | -.462 ( 187) |
| RHD | -.064 ( 186) | -.101 ( 186) | -.074 ( 187) | .304 ( 187) | -.004 ( 187) | -.090 ( 187) | .151 ( 187) | .177 ( 187) | .026 ( 187) | -.071 ( 187) |
| A-AA | -.104 ( 186) | .061 ( 186) | .337 ( 187) | .010 ( 187) | -.123 ( 187) | -.088 ( 187) | .884 ( 187) | .540 ( 187) | .174 ( 187) | -.267 ( 187) |
| B-BB | -.085 ( 186) | .017 ( 186) | .254 ( 187) | .048 ( 187) | -.031 ( 187) | -.094 ( 187) | .783 ( 187) | .501 ( 187) | .053 ( 187) | -.291 ( 187) |
| C-CC | -.033 ( 186) | -.018 ( 186) | .023 ( 187) | .081 ( 187) | .058 ( 187) | -.096 ( 187) | .425 ( 187) | .165 ( 187) | .050 ( 187) | -.184 ( 187) |

CORRELATION ANALYSIS

TABLE OF CORRELATIONS AND COUNTS

| | REFM | IM/RM | RHM | RHD | A-AA | B-BB | C-CC |
|---|---|---|---|---|---|---|---|
| REFM | 1.000<br>( 187) | | | | | | |
| IM/RM | -.547<br>( 187) | 1.000<br>( 187) | | | | | |
| RHM | -.363<br>( 187) | .093<br>( 187) | 1.000<br>( 187) | | | | |
| RHD | -.028<br>( 187) | -.042<br>( 187) | .002<br>( 187) | 1.000<br>( 187) | | | |
| A-AA | -.216<br>( 187) | -.032<br>( 187) | .191<br>( 187) | .121<br>( 187) | 1.000<br>( 187) | | |
| B-BB | -.203<br>( 187) | -.063<br>( 187) | .222<br>( 187) | .152<br>( 187) | .913<br>( 187) | 1.000<br>( 187) | |
| C-CC | -.147<br>( 187) | -.038<br>( 187) | .036<br>( 187) | .095<br>( 187) | .558<br>( 187) | .639<br>( 187) | 1.000<br>( 187) |

CORRELATION ANALYSIS

TABLE OF MEANS AND STANDARD DEVIATIONS

THE NUMBERS ENTERED BELOW NOT ENCLOSED IN PARENTHESES ARE THE MEANS FOR THE VARIABLES IDENTIFIED DOWN THE PAGE USED IN THE CORRELATION COMPUTATION WITH THE VARIABLES IDENTIFIED ACROSS THE PAGE. THE NUMBERS IN PARENTHESES ARE THE STANDARD DEVIATIONS FOR THE SAME VARIABLES.

| | HC | TISTB | TEMPM | TEMPD | APM | APD | DBAM | DBBM | DSCM | ILLM |
|---|---|---|---|---|---|---|---|---|---|---|
| HC | 4.344 | 4.344 | 4.344 | 4.344 | 4.344 | 4.344 | 4.344 | 4.344 | 4.344 | 4.344 |
| | ( 4.376) | ( 4.376) | ( 4.376) | ( 4.376) | ( 4.376) | ( 4.376) | ( 4.376) | ( 4.376) | ( 4.376) | ( 4.376) |
| TISTB | .096 | .096 | .096 | .096 | .096 | .096 | .096 | .096 | .096 | .096 |
| | ( .060) | ( .060) | ( .060) | ( .060) | ( .060) | ( .060) | ( .060) | ( .060) | ( .060) | ( .060) |
| TEMPM | 73.895 | 73.895 | 73.894 | 73.894 | 73.894 | 73.894 | 73.894 | 73.894 | 73.894 | 73.894 |
| | ( 2.367) | ( 2.367) | ( 2.361) | ( 2.361) | ( 2.361) | ( 2.361) | ( 2.361) | ( 2.361) | ( 2.361) | ( 2.361) |
| TEMPD | 3.651 | 3.651 | 3.642 | 3.642 | 3.642 | 3.642 | 3.642 | 3.642 | 3.642 | 3.642 |
| | ( 2.286) | ( 2.286) | ( 2.283) | ( 2.283) | ( 2.283) | ( 2.283) | ( 2.283) | ( 2.283) | ( 2.283) | ( 2.283) |
| APM | 29.914 | 29.914 | 29.911 | 29.911 | 29.911 | 29.911 | 29.911 | 29.911 | 29.911 | 29.911 |
| | ( .375) | ( .375) | ( .376) | ( .376) | ( .376) | ( .376) | ( .376) | ( .376) | ( .376) | ( .376) |
| APD | .019 | .019 | .019 | .019 | .019 | .019 | .019 | .019 | .019 | .019 |
| | ( .020) | ( .020) | ( .020) | ( .020) | ( .020) | ( .020) | ( .020) | ( .020) | ( .020) | ( .020) |
| DBAM | 56.674 | 56.674 | 56.692 | 56.692 | 56.692 | 56.692 | 56.692 | 56.692 | 56.692 | 56.692 |
| | ( 4.097) | ( 4.097) | ( 4.093) | ( 4.093) | ( 4.093) | ( 4.093) | ( 4.093) | ( 4.093) | ( 4.093) | ( 4.093) |
| DBBM | 60.151 | 60.151 | 60.162 | 60.162 | 60.162 | 60.162 | 60.162 | 60.162 | 60.162 | 60.162 |
| | ( 4.103) | ( 4.103) | ( 4.095) | ( 4.095) | ( 4.095) | ( 4.095) | ( 4.095) | ( 4.095) | ( 4.095) | ( 4.095) |
| DSCM | 66.593 | 66.593 | 66.591 | 66.591 | 66.591 | 66.591 | 66.591 | 66.591 | 66.591 | 66.591 |
| | ( 3.455) | ( 3.455) | ( 3.446) | ( 3.446) | ( 3.446) | ( 3.446) | ( 3.446) | ( 3.446) | ( 3.446) | ( 3.446) |
| ILLM | 66.565 | 66.565 | 66.422 | 66.422 | 66.422 | 66.422 | 66.422 | 66.422 | 66.422 | 66.422 |
| | ( 33.282) | ( 33.282) | ( 33.249) | ( 33.249) | ( 33.249) | ( 33.249) | ( 33.249) | ( 33.249) | ( 33.249) | ( 33.249) |
| REFM | 13.785 | 19.785 | 19.738 | 19.738 | 19.738 | 19.739 | 19.738 | 19.738 | 19.738 | 19.738 |
| | ( 14.172) | ( 14.172) | ( 14.149) | ( 14.149) | ( 14.149) | ( 14.149) | ( 14.149) | ( 14.149) | ( 14.149) | ( 14.149) |
| IM/RM | 3.712 | 3.712 | 3.711 | 3.711 | 3.711 | 3.711 | 3.711 | 3.711 | 3.711 | 3.711 |
| | ( .881) | ( .881) | ( .879) | ( .879) | ( .879) | ( .879) | ( .879) | ( .879) | ( .879) | ( .879) |
| RHM | 36.753 | 36.754 | 36.727 | 36.727 | 36.727 | 36.727 | 36.727 | 36.727 | 36.727 | 36.727 |
| | ( 8.893) | ( 8.893) | ( 8.885) | ( 8.885) | ( 8.885) | ( 8.885) | ( 8.885) | ( 8.885) | ( 8.885) | ( 8.885) |
| RHD | 5.043 | 5.043 | 5.037 | 5.037 | 5.037 | 5.037 | 5.037 | 5.037 | 5.037 | 5.037 |
| | ( 5.190) | ( 5.190) | ( 5.176) | ( 5.176) | ( 5.176) | ( 5.176) | ( 5.176) | ( 5.176) | ( 5.176) | ( 5.176) |
| A-AA | 16.362 | 16.362 | 16.390 | 16.390 | 16.390 | 16.390 | 16.390 | 16.390 | 16.390 | 16.390 |
| | ( 6.800) | ( 6.800) | ( 6.793) | ( 6.793) | ( 6.793) | ( 6.793) | ( 6.793) | ( 6.793) | ( 6.793) | ( 6.793) |
| B-BB | 12.445 | 12.445 | 12.464 | 12.464 | 12.464 | 12.464 | 12.464 | 12.464 | 12.464 | 12.464 |
| | ( 7.033) | ( 7.033) | ( 7.084) | ( 7.084) | ( 7.084) | ( 7.084) | ( 7.084) | ( 7.084) | ( 7.084) | ( 7.084) |
| C-CC | 11.044 | 11.044 | 11.039 | 11.039 | 11.039 | 11.039 | 11.039 | 11.039 | 11.039 | 11.039 |

CORRELATION ANALYSIS

TABLE OF MEANS AND STANDARD DEVIATIONS

| | REFM | IM/RM | RHM | RHO | A-AA | B-BB | C-CC |
|---|---|---|---|---|---|---|---|
| HC | 4.344 | 4.344 | 4.344 | 4.344 | 4.344 | 4.344 | 4.344 |
| | ( 4.376) | ( 4.376) | ( 4.376) | ( 4.376) | ( 4.376) | ( 4.376) | ( 4.376) |
| TISTB | .096 | .096 | .096 | .096 | .096 | .096 | .096 |
| | ( .060) | ( .060) | ( .060) | ( .060) | ( .060) | ( .060) | ( .060) |
| TEMPM | 73.894 | 73.894 | 73.894 | 73.894 | 73.894 | 73.894 | 73.894 |
| | ( 2.361) | ( 2.361) | ( 2.361) | ( 2.361) | ( 2.361) | ( 2.361) | ( 2.361) |
| TEMPD | 3.642 | 3.642 | 3.642 | 3.642 | 3.642 | 3.642 | 3.642 |
| | ( 2.283) | ( 2.283) | ( 2.283) | ( 2.283) | ( 2.283) | ( 2.283) | ( 2.283) |
| APM | 29.911 | 29.911 | 29.911 | 29.911 | 29.911 | 29.911 | 29.911 |
| | ( .376) | ( .376) | ( .376) | ( .376) | ( .376) | ( .376) | ( .376) |
| APD | .019 | .019 | .019 | .019 | .019 | .019 | .019 |
| | ( .020) | ( .020) | ( .020) | ( .020) | ( .020) | ( .020) | ( .020) |
| DBAM | 56.692 | 56.692 | 56.692 | 56.692 | 56.692 | 56.692 | 56.692 |
| | ( 4.093) | ( 4.093) | ( 4.093) | ( 4.093) | ( 4.093) | ( 4.093) | ( 4.093) |
| DBBM | 60.162 | 60.162 | 60.162 | 60.162 | 60.162 | 60.162 | 60.162 |
| | ( 4.095) | ( 4.095) | ( 4.095) | ( 4.095) | ( 4.095) | ( 4.095) | ( 4.095) |
| DBCM | 66.591 | 66.591 | 66.591 | 66.591 | 66.591 | 66.591 | 66.591 |
| | ( 3.446) | ( 3.446) | ( 3.446) | ( 3.446) | ( 3.446) | ( 3.446) | ( 3.446) |
| ILLM | 66.422 | 66.422 | 66.422 | 66.422 | 66.422 | 66.422 | 66.422 |
| | ( 33.249) | ( 33.249) | ( 33.249) | ( 33.249) | ( 33.249) | ( 33.249) | ( 33.249) |
| REFM | 19.738 | 19.738 | 19.738 | 19.738 | 19.738 | 19.738 | 19.738 |
| | ( 14.149) | ( 14.149) | ( 14.149) | ( 14.149) | ( 14.149) | ( 14.149) | ( 14.149) |
| IM/RM | 3.711 | 3.711 | 3.711 | 3.711 | 3.711 | 3.711 | 3.711 |
| | ( .879) | ( .879) | ( .879) | ( .879) | ( .879) | ( .879) | ( .879) |
| RHM | 36.727 | 36.727 | 36.727 | 36.727 | 36.727 | 36.727 | 36.727 |
| | ( 8.885) | ( 8.885) | ( 8.885) | ( 8.885) | ( 8.885) | ( 8.885) | ( 8.885) |
| RHO | 5.037 | 5.037 | 5.037 | 5.037 | 5.037 | 5.037 | 5.037 |
| | ( 5.176) | ( 5.176) | ( 5.176) | ( 5.176) | ( 5.176) | ( 5.176) | ( 5.176) |
| A-AA | 16.390 | 16.390 | 16.390 | 16.390 | 16.390 | 16.390 | 16.390 |
| | ( 6.793) | ( 6.793) | ( 6.793) | ( 6.793) | ( 6.793) | ( 6.793) | ( 6.793) |
| B-BB | 12.464 | 12.464 | 12.464 | 12.464 | 12.464 | 12.464 | 12.464 |
| | ( 7.084) | ( 7.084) | ( 7.084) | ( 7.084) | ( 7.084) | ( 7.084) | ( 7.084) |
| C-CC | 11.039 | 11.039 | 11.039 | 11.039 | 11.039 | 11.039 | 11.039 |
| | ( 11.232) | ( 11.232) | ( 11.232) | ( 11.232) | ( 11.232) | ( 11.232) | ( 11.232) |